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The Eighty-First Meeting of the American Astronomical Society

By CURVIN H. GINGRICH

At the invitation of Dr. C. S. Beals, Director of the Dominion Observatory, the eighty-first meeting of the American Astronomical Society convened at Ottawa, Ontario, on June 19, and continued its sessions until the morning of June 23. A meeting of the Council was the only formal event scheduled for the afternoon of the first day, which was Sunday. Other members who arrived in time had the opportunity of an early inspection of the Dominion Observatory and of the lovely gardens surrounding it. By Monday morning most of the members and their guests had arrived and a number of them found that reservations had been made for them at the comfortable and palatial Lord Elgin Hotel.

The opening formal session was called to order at nine o'clock by the president, Dr. Otto Struve. This session as well as all the other sessions for papers was held in the spacious auditorium of the building which houses the various activities of the National Research Council. Before the presentation of papers was begun the formalities which are customary on such occasions were carried out. Dr. C. K. MacKenzie, President of the National Research Council, spoke first. He explained the numerous projects being carried on under the direction of the National Research Council, and then extended a hearty welcome to the Society to hold its sessions in his building. He was followed by Dr. C. S. Beals, who explained the organization of the several astronomical observatories in Canada and further very warmly welcomed the guests in the name of the Dominion Observatory and of the city of Ottawa. He also called attention to the fact that this international gathering, although on a somewhat restricted scale, was an indication of a growing understanding and world community among scientists. After announcements by Dr. Herzberg, Director of Physics of the National Research Council, and by Dr. Millman, a member of the staff of the Dominion Observatory, the reading of papers was begun, Dr. Struve presiding.

Promptly at twelve-thirty, the time scheduled for taking the photograph of the group, the session was adjourned. The weather conditions were favorable with the result that a very good picture including 155 persons was obtained. However, a few minutes after the exposure was made rain began to fall and the party sought the shelter of the commodious N.R.C. building, a name quickly adopted by all visitors, near-

by. Indicative of the thoughtfulness with which the plans were made by the local committees, was the fact that the cafeteria of the N.R.C. served special luncheons for the visitors for the three days during which the sessions were held there. The presentation of scheduled papers was resumed at two-thirty and continued throughout the afternoon, Dr. Whipple presiding.

The evening of Monday was devoted to becoming acquainted with each other on a social basis as well as on a professional one. The entire group was invited to be the guests of the Dominion Observatory and the Ottawa Centre of the Royal Astronomical Society of Canada at a Garden Party and Open House at the Dominion Observatory from seven to ten. We found guides and lecturers stationed in the various rooms of the Observatory, who explained the nature of the several pieces of work in progress and the techniques employed. Later in the evening, without exception, the guests wandered across the lawn to a spacious marquee furnished with chairs and with tables laden with tempting viands of many kinds. My observation seemed to indicate that the group was inclined to linger here longer than with the observatory instruments. The party of which I was a member, and it was by no means the last to leave, returned to the hotel at an hour which indicated that we had somewhat extended the hours announced.

Two sessions were held at the N.R.C. on Tuesday, one at nine-thirty, Dr. Goldberg presiding, and one at two-thirty, Dr. Shapley presiding. The former was devoted to a continuation of scheduled papers and the latter to a symposium on meteoric astronomy. The latter consisted of five invited papers by Charles P. Olivier, Peter M. Millman, L. A. Manning and Oswald G. Villard, Jr., D. W. R. McKinley, and Fred L. Whipple, in order. At the conclusion of the papers Dr. Shapley commented on the status of meteoric astronomy and on astronomical progress generally. He listed five features which are contributing to the present rapid progress, as follows: 1. The large reflectors; 2. The development and adaptation of the Schmidt telescope; 3. The photoelectric tube; 4. The solar coronagraph and attendant instruments; 5. Micro-wave astronomy, the last being used so successfully in detecting meteors. The session was adjourned at five o'clock.

The meeting reached a climax on Tuesday evening. This evening was reserved for the third Henry Norris Russell Lecture. The auditorium in the Victoria Memorial Museum was reserved for this event. The museum was opened an hour before the scheduled time for the lecture so that the guests might enjoy the exhibits there. In addition to the usual museum exhibits one finds here a very large collection of American Indian relics. One would need many hours to do full justice to this phase of the museum alone. The lecture was given to a capacity audience at eight-thirty. At that time Dr. Struve introduced the lecturer, Dr. S. Chandrasekhar, of the Yerkes Observatory and Distinguished Service Professor of the University of Chicago. The title of this third

lecture in the series was "Turbulence—A Physical Theory of Astrophysical Interest." This lecture was the concluding feature of a busy, very interesting, and very warm day.

On Wednesday morning at nine-thirty, the reading and discussion of papers was resumed, and, with an intermission from eleven to eleven-thirty, was continued until one. Dr. Spitzer presided at this session. After lunch, the annual business meeting was made the order of the day, with the president, Dr. Struve, presiding. The secretary read the list of names of persons elected to membership by the Council, as follows:

H. Arthur Abt, California Institute of Technology
M. K. Vainu Bappu, Harvard College Observatory
Professor Harrison Brown, University of Chicago
Helen Spence Federer, Harvard College Observatory
H. Harold Hartzler, Goshen College, Indiana
Ralph U. Nichols, University of Western Ontario
Yale K. Roods, New York University
Harlan J. Smith, Harvard College Observatory
Chhotubhai S. Suthar, Anand, India

The secretary also announced the election of Professor A. Kopff, Heidelberg, Germany, to honorary membership in the Society.

After this the president requested the audience to stand as a memorial to the eight members who had died within the past year. The names were read by the secretary as follows:

H. E. Burton
G. Clyde Fisher
Henry G. Gummere
Frank S. McGary
J. H. Moore
Arthur J. Roy
Richard C. Tolman
Carr V. Van Anda.

The secretary then presented some statistics relative to the membership of the Society. In the last three years the membership increased in number from 525 to 675. The result of the ballot taken by mail for new officers, in which more than three hundred ballots were cast, was announced. Officers for the ensuing period are

Dr. Alfred H. Joy, President
Dr. Dirk Brouwer, Vice-President
Dr. C. M. Huffer, Secretary
Dr. J. J. Nassau, Treasurer
Dr. G. M. Clemence, Dr. G. P. Kuiper, and Dr. Andrew McKellar, Councilors.

The voting on the proposed amendment to the Constitution of the Society resulted in an insufficient number of favorable votes for adoption. Accordingly a special committee consisting of Dr. Shapley, Dr. Joy, and Dr. Huffer was appointed to revise the proposed amendment

for consideration at some future time. The amendment to the By-Laws increasing the annual membership dues from three dollars to five dollars was passed without opposition.

The ballot taken on the seven nominees for membership on the nominating committee resulted in the election of Dr. Schwarzschild, Chairman, Dr. Pearce, and Dr. Hall.

Dr. Fletcher Watson of the Harvard College Observatory was added to the Teachers Committee of the Society. No report of this committee was at hand for this meeting. The few remaining papers on the list were then given, bringing the total number of papers to 60.

The business having been completed, the Chairman was about to adjourn the meeting, when Dr. Shapley arose and briefly reviewed the progress of the Society during the administration just closing. That the persistent and effective efforts which Dr. Struve had given to the welfare of the Society during the last three years were well known and heartily appreciated by all present was fully attested by the sincerity of the ovation which was given Dr. Struve at the conclusion of Dr. Shapley's remarks. With it the scientific and official part of the eighty-first meeting was concluded.

The Society dinner was still to come. This was scheduled for seven o'clock that evening at the Chateau Laurier Hotel, which is characterized as Canada's premier hotel. The banquet room of this fine hotel afforded a beautiful setting for the occasion. A high table was arranged for fifteen persons, officers of the Society, officials of the Canadian Government, and invited guests. The usual banquet menu was served tastily and with dispatch. Following the dinner, Dr. Fred L. Whipple took the rôle of toastmaster. He first introduced the several persons occupying places at the high table. He then called upon Dr. Hugh L. Keenleyside, minister in the Department of Mines and Resources, who explained the history by which the astronomical observatories of Canada became a branch of the Bureau of Mines. In brief, the present organization stems from the time when the major task of the astronomers was the determination of geographical boundaries between the provinces and, indeed, between Canada and the United States. His talk was replete with anecdote and information and again illustrated the thought expressed at the opening session that there are no international boundaries in science. Dr. Whipple then called upon the retiring president of the Society, Dr. Struve. He spoke very interestingly and authoritatively concerning the status of the International Astronomical Union, in the resuscitation of which he is playing such a prominent part. He said that, although some negotiations for holding the next assembly in 1951 in Russia have taken place, present indications are that it will be held in one of the smaller European countries.

Next came Dr. Newton L. Pierce, of Princeton University, to whom had been entrusted the difficult task of giving adequate expression to the unanimous feeling of indebtedness on the part of all the visitors for

the courtesies and hospitality extended to them during the preceding days. Dr. Pierce arose to the occasion with these words:

"The American Astronomical Society wishes to express its appreciation to the Department of Mines and Resources of Canada for the fine support it has given and is giving to astronomical research. It is with particular pleasure that we have come to Ottawa for our eighty-first meeting. We have been impressed by the excellence of the facilities placed at our disposal for the formal sessions of our meeting, and equally pleased by the thoughtfulness with which our comfort and pleasure have been provided for.

"We express our heartfelt thanks to the Department of Mines and Resources, to the Honourable Colin Gibson, Minister of the Department of Mines and Resources, to Dr. Keenleyside, the Deputy Minister, to Dr. Timm, Director of the Branch of Mines, Forests and Scientific Services, and to his successor, Dr. Hume. We are equally appreciative of the kindness of the National Research Council of Canada in providing such excellent facilities in its fine building. We give our thanks to Dr. MacKenzie, Director of the National Research Council, to Dr. Herzberg, Director of the Physics Division, and to the members of their staff who so well provided for our needs.

"To Dr. and Mrs. C. S. Beals and the staff of the Dominion Observatory we express our special thanks for their kind invitation to meet here and for all they have done to make our stay here both pleasant and profitable. We thoroughly enjoyed the garden party and open house at the Dominion Observatory, and offer our thanks to the Observatory staff and to the Ottawa Centre of the Royal Astronomical Society of Canada for this pleasant occasion.

"The ladies of the society are particularly appreciative of the tours to Mountain Lodge and to the Houses of Parliament especially arranged for their benefit. Many members of the society who are able to spare an extra day are looking forward with pleasure to the tours planned for tomorrow.

"For taking care of the many details which have added so much to the success of the meeting our special thanks go to Dr. and Mrs. Peter Millman and to those members of the Ottawa Centre of the Royal Astronomical Society of Canada who manned the registration desk.

"At Mountain Lodge some of the ladies observed the following sign: 'Why be Difficult when with just a little more effort you can be Impossible?' We know that we have been difficult guests at times, but we hope not too often impossible. If our generous hosts should be kind enough to say that we have not been *too* impossible, we can only say that it is their kindness and thoughtfulness which have kept us from expending that 'little more effort'."

This concluded the speaking for the evening. However, a rare treat

was still in store. The local committee had arranged for the showing of a moving picture, an anthropological film, in technicolor depicting early Canadian history, featuring the early life of the Indian, making special use of his masks and lore. The picture was entitled "The Loon's Necklace," and was characterized as the film of the year in Canada. It was so thoroughly enjoyed that at the close requests were promptly made for a second showing. This request was readily and graciously granted. The party then fell to bidding farewells and slowly disbanded.

For those whose time permitted, three tours were arranged for the following morning.

1. Bureau of Mines, Department of Mines and Resources.
2. Radio Field Station of the National Research Council.
3. Mechanical Engineering Laboratories of the National Research Council.

The number of signatures in the secretary's roster is 147, and the number of individuals in the photograph is 155. The eighty-first meeting cannot therefore be said to have been one of the largest, but the consensus unmistakably seemed to be that it was one of the best.

Behavior of the Atmosphere under Atomic Disruption

By BEN HUR WILSON

It may, perhaps, seem a bit presumptuous for one, who has not had any connection with the development of the atomic bomb, to attempt any serious discussion of its attendant phenomena. However, having long been interested in the subject of the behavior of the upper atmosphere while under the influence of metoric bombardment, it is only natural that one's mind should revert to that type of thinking upon reading the description of the visible phenomena connected with the explosion.

In preparing to assume the consequences of such cataclysmic destruction, one of the biggest questions which arose in the minds of everybody was the possibility of touching off a chain of reactions which might gravely affect life on the planet, or even the life of the planet itself. Involvements along this line were several in number. Chief of these "fears" was the effect it might have upon our atmosphere which, after long eons of time, had been so well purified, solely through natural agencies, as to make it ideal for the existence of life, such as we know it, on the planet.

It is well known that even relatively small changes in percentage composition, might readily affect important natural balances, thereby bringing about very startling and no doubt serious results. This matter is not an entirely new anxiety of scientists, for astronomers and

geologists have long since discussed such likelihood, by reason of cosmic accident, and I think it was Chamberlain[1] who said that, should the Earth's atmosphere ever be wholly or partially destroyed, it could acquire a new or renewed one, substantially the same as the one it now has, over a period of about one-hundred million years. The source of this new atmosphere would be the volcanic and occluded gases of the lithosphere, enriched by elements acquired through meteoric disintegration and other cosmic debris.

Before commencing our speculation upon the *Behavior of the Atmosphere under Atomic Disruption*, it may be desirable to refresh our memories concerning some of the details of its physical nature. We shall attempt to do this without bringing in too much irrelevant material. The Earth's atmosphere consists principally of a number of gases, both elemental and compound, together with varying amounts of water vapor and solid matter which may be found floating through it, as dust, smoke, meteoric residuals, etc.

These gases, existing together as a physical mixture are free, therefore, to move or shift about vertically according to the dictates of their own gravities. Thus, the percentage composition of the atmosphere changes greatly at various elevations above sea level,—so much so, indeed, that its component composition existing in the lower reaches scarcely resembles that which is to be found at much higher altitudes.

For example, near sea level, the zone with which we are especially concerned in our present discussion, the percentage composition of the atmosphere, as given by Humphreys,[2] is as follows: Nitrogen, 78.04%; Oxygen, 20.99%; Argon, 0.94%; Carbon dioxide, 0.03%; in addition to traces of numerous other gaseous compounds and varying quantities of water vapor; while at 150 km., it consists mainly of rarefied Hydrogen gas, (95%), with a trace of helium,—little or no water vapor being present.

The quantity of water vapor which air may absorb depends upon its temperature, and to a lesser degree upon atmospheric pressure. This is called the humidity. Humidity is measured by the number of grains of water vapor present in a cubic foot of air. The amount actually present at any given moment is spoken of as the *absolute humidity*. The quantity of water vapor which the air may hold under any given condition of temperature and pressure is called its *capacity*, and the ratio of the *absolute humidity* to *capacity* is called *relative humidity*. Habitually low humidity in a region results in aridity, and the opposite produces conditions more or less humid, depending upon the degree. These are all points which have considerable bearing upon our problem, and, as such, they must to a certain extent, direct or modify our conclusions.

While water vapor, on account of its great variability in quantity, might be considered as only an adjunct to the atmosphere, it is at the same time of such vast importance that we cannot neglect saying a few

more words clarifying its position. This variability is due, first, to its availability, which is dependent more or less upon temperature, and to its source of supply; and second, to the physical ability of the atmosphere to hold it. It is, in fact, actually absorbed into the interstices existing between the gaseous atoms and molecules of the air, and whenever these spaces are filled, the "saturation point" is said to have been reached. Any change in the temperature of the air, therefore, modifies this ability to hold moisture, and, when fully saturated air is cooled, contraction takes place, bringing about condensation.

One of the extremely fortunate circumstances concerning the composition of the atmosphere is the relative proportion by volume existing between oxygen, (20.99%) and nitrogen, (78.07%). The great activity of the element oxygen is thus held in check by the reduction of its concentration. Were it not for this fact it would be difficult to predict all of the consequences of the increased rate of oxidation, metabolism, and other chemical activities which would thus ensue. The oxygen-tent employed in hospitals is an excellent example of what we have in mind. Any cataclysmic event occurring in nature, or even artificially, such as atomic bombardment, involving, upon any considerable scale, the oxygen content of the air, must therefore have profound effect upon our physical well-being.

While the carbon dioxide content (0.0003) of the atmosphere appears so small as to be almost non-appreciable, in the aggregate it amounts to enormous quantities. Krogh[3] estimates the total amount of carbon dioxide in the atmosphere to be about 2,200,000,000,000 tons, equivalent to some 600,000,000,000 tons of pure carbon. Carbon exists in a number of allotropic forms, such as diamond, graphite, charcoal, and lamp black or pure soot. It is this most evident form with which we are here particularly concerned.

Functionally, carbon dioxide is, aside from water, nature's most important chemical compound. Upon these two simple substances, water and carbon dioxide, and their ability to combine, in nature, by means of the process of photosynthesis, to form sugar, hinges almost the entire array of organic life upon the Earth. We may be sure that carbon dioxide, which is constantly being withdrawn from the atmosphere in various ways, is at the same time being returned by other means, in sufficient quantities to keep its available supply nicely balanced from one geological age to the next. In considering all *Natural Balances,* we find this one probably the most important and likewise one of the most perfectly maintained.

Both water and carbon dioxide are, under ordinary circumstances, quite stable compounds. However, as temperature is increased, a critical point is reached where every compound will dissociate into its individual component elements. It is doubted if any terrestrial compound may continue to exist at temperatures as great as 6000° Centigrade. This temperature is trivial when compared to that existing even

upon the surface of the sun, which is said to be between 12,000° and 15,000° C., while Dr. J. J. Nassau[4] claims that the Sun's interior temperature may exceed the enormous value of 20,000,000° C. The heat which is produced by the explosion of the atomic bomb, is said to be equivalent to the Sun's energy, and must therefore fall somewhere between these two extremes.

Kassel[5] states that even at the modest temperature of 2,000° C. carbon dioxide is 1.55% dissociated into carbon monoxide and oxygen, and while it does not support ordinary combusion, the more active elements, such as magnesium, will burn in it leaving black carbon. It is my contention that the great, rolling, dense, black clouds witnessed at high altitudes above the explosion of the atomic bomb may, at least in part, have been the result of the dissociation of the carbon dioxide of the atmosphere coming under the direct influence of the intense heat of the atomic disruption, resulting in the liberation of gaseous oxygen and free atomic carbon in the form of soot. Upon reuniting probably not all of the carbon present recombined.

Likewise, all of the liquid water such as fog, rain, or clouds existing in the atmosphere is instantly vaporized, being expanded thereby to many thousands of times its former volume, which, in turn together with whatever additional water vapor (humidity) may be present, is also dissociated by the intense heat of the atomic explosion, resulting in the liberation of enormous quantities of hydrogen and an additional amount of free oxygen. Without taking into account any of the effects which may at the same time have taken place upon the Earth's surface, here are at least two important sources for enrichment of the percentage composition of atmospheric oxygen within the immediate vicinity of the catastrophe.

The atomic forces having finally spent themselves, there is then a period following during which dissipation of the intense heat of the blast occurs. The extreme or peak temperature soon drops to the point where normal or ordinary combustion and other forms of chemical reaction may take place as a result of the physical rearrangement of the elements within the zone of the disturbance. During this period, conditions must exist similar to those which probably occurred upon the original cooling of our primordial hot earth. If we may but allow our imagination to play upon the subject, we will have no trouble conjuring up many interesting pictures not ordinarily called to mind.

At this point it may be well for us again to digress briefly and review our common concepts concerning the true nature of combustion. Just what is meant by the term combustion?

Our first thought on the matter, it seems, is that combusion simply means burning, and that is about all there is to it. However, when the process is examined more carefully and critically, we soon discover that it is not so simple as all that, and that really there are many angles to

be considered. Under what condition does combustion take place, and why do some things burn while others do not?

Commonly speaking, the phenomenon of combustion is considered to be the rapid oxidation of some substance, more often some compound or compounds of carbon, with which oxygen will readily unite. The process of oxidation may be slow, as that taking place within our own bodies; or, medium as that under ordinary conditions; or, rapid as under forced draft, in an oxygen enriched atmosphere, or as when some explosion occurs. In case the resultant chemical reaction is such as to create certain molecular disturbances within the ether, waves are thrown off which we recognize as light or "a flame," this being indicative of true combusion as we ordinarily speak of it. In other words, the difference between oxidation and combustion is merely a matter of degree.

Technically, many elements other than carbon, under proper conditions, involving such matters as concentrations, pressures, and temperatures, will also unite with oxygen to produce similar physical results. Even iron will burn vigorously in an atmosphere of pure oxygen. Oxygen, too, is not alone in its ability to support combusion, for in the laboratory, and occasionally in nature, as in certain volcanic activities, iodine, chlorine, and some other substances will perform the same functions as oxygen, producing incandescence.

Under atomic fission, however, the intense light and heat are produced as a result of the readjustment of the nuclear matter within certain involved elements, and its conversion into physical energy, rather than by any ordinary form of chemical activity. Herein then lies a significant difference which must not be lost sight of in our evaluation of the immediate effects of atomic disruption upon our atmosphere. At this stage one might well inquire as to just why astronomers should seriously concern themselves with anything so trivial as the Earth's atmosphere, it being only one of the minor planets. When we recall, however, that it is through this medium that every single observation made by them takes place, and that all light entering our telescopes and other instruments of observation is screened and conditioned by it, we immediately perceive that anything affecting the atmosphere, even in the slightest degree, must at once become a matter of extraordinary significance, worthy of our most careful study.

A few words upon the matter of luminescence may also not be out of order here. This is a term employed for the phenomenon of light which is more intense than the corresponding heat would seem to indicate. In these days of modern electrical illumination most of us have lost sight of its full significance. Some substances attain white heat at a much lower temperature than others. Two examples will, perhaps, suffice to illustrate our point. Hydrogen burns in oxygen with a pale, blue, non-luminous flame. While this oxyhydrogen flame is scarcely visible in a well-lighted room, if it be projected against a ball

of calcium oxide, incandescence of intense brilliancy occurs which early writers referred to as the "lime-ball light." Carbon under perfect combustion also burns with a deep blue flame, while under imperfect combustion (insufficient oxygen), the unburned surplus of free carbon, in the form of soot, becomes incandescent, exhibiting a bright yellow flame. All who have used a Bunsen burner must be familiar with this.

Hence, the phenomenon of light and its analysis, both visually and spectroscopically, connected with the explosion of the atomic bomb cannot be overlooked. It should certainly be the assisting clue by means of which we may be enabled to piece together at least a partial pattern of the actual events which may have occurred. Many elements, when under the influence of intense heat, impart a significant, distinctive color to the flame, which enables them to be readily identified by the trained analysts. While marked advancements in modern scientific methods, such as the employment of the arc and spark spectroscopic analysis, have rendered such schemes as blow-pipe analysis comparatively obsolete, in time past and even today they have oft-times proven to be of incalculable value.

Perhaps, we may now have enough facts before us to permit our formulating some pertinent conclusions concerning the *Behavior of the Atmosphere under Atomic Disruption.* In attempting such résumé, we have but one thought in mind, namely, to present a congruent picture of what actually takes place, for the benefit of laymen, as well as for those scientists who are not now specializing in the field of physical research. The present effort, it seems, should aid in a better visualization of the entire situation, as without such review it is possible that most of us would be required to give the matter much more thought and study than the average individual in these busy days might find time for.

The moment the "atomic explosion" occurs, through fission of the unstable isotope U. 235, or of other possible elements, atoms of some twenty or more different types of a lighter atomic weight may be created, such as xenon, strontium, rubidium, caesium, krypton, barium, etc., (see Smyth Report, pp. 135-36). In this event, however, it must be understood, that no new matter has actually been created, as it is only a rearrangement of the original that has taken place. Incorporated into the physical structure of these new atoms are to be found practically all of the electrons and protons which were contained in the original mass. This is not true, however, of the neutrons, of which there is a certain excess number remaining free and uncontrolled. Having now no other restraining force, some are thereupon dissipated into thermal energy according to Einstein's famous formula $E = mc^2$, in which E stands for energy, m for mass, and c for the velocity of light. This intense heat, thus produced by atomic fission, is likewise responsible for the light and other striking phenomena observed, rather than from any

form of chemical reaction, as would be true in an ordinary type explosion.

It is from this point that we shall now proceed with our discussion; since, we are not here greatly concerned with either the nature of the explosion or the manner in which it was brought about. It is results in which we are primarily interested. Our purpose, perhaps, will be better served by organizing our thoughts concerning the succeeding events which may have taken place according to the following outline. (1) Period of ascending temperature gradient,—that of disruption, disintegration of compounds, and vaporization of elements. (2) Period of descending temperature gradient,—integration, and reformation of compounds,—with its consequent realignment of elements. A period of intense chemical activity. (3) The "hangover" period,—a period of movement and consequences; more important, perhaps, in its far-reaching effects than either of the other two periods.

Many of our ideas concerning the first period have been variously stated in earlier parts of our paper, and so require little further elaboration. Recapitulating, then, we have in mind the following evident facts. (a) All elements vaporize at temperatures far below maximum atomic heat. (b) Similiarly, all chemical compounds dissociate, or resolve themselves into their individual component elements, at much less than the degree of temperature indicated. (c) Enormous pressures are created in the atmosphere, radiating outward from the point of explosion, which are in turn followed by a vacuous condition of like intensity. (d) Tremendous new volumes of various gases are generated by the explosion and consequent vaporization of large quantities of solid and liquid matter existing nearby. (e) In the atmosphere itself, all carbon dioxide gas coming under the influence of the intense atomic heat is immediately dissociated into the elements of oxygen and free carbon. While carbon requires one of the highest volatilization temperatures of all elements, that which is at or near the center of the explosion is undoubtedly immediately vaporized. That existing farther out, around the margins of the affected area must remain in its solid form, and appears in the huge, enveloping, dense, black clouds of smoke (soot) which are clearly shown in the earliest pictures taken of the phenomenon near the Alamogardo Air Base, in New Mexico, on the morning of July 16, 1945. (f) Likewise, all liquid moisture, existing as clouds in the lower atmosphere, is instantly vaporized and, together with whatever other water vapor is present, then dissociated into free hydrogen and oxygen gas. (g) From these sources, (e and f), the free oxygen content of the atmosphere is greatly augmented. (h) In addition, great quantities of oxygen gas are also liberated, to be added to the total, from volatilized and dissociated surface materials, practically 50% of which, we should say, is composed of combined oxygen. (i) No doubt, additional gaseous and volatilized atoms of various other elements, which are present locally are also released from the mineral

compounds, and from such materials as civilized man may have contributed for the occasion. (j) That this is true, is indicated by the intense multi-colored flames, described as "golden, purple, violet, gray, and blue," which accompanied the phenomenon. These apparently were the result of various surficial materials being raised to white hot incandescence. They are important as aids in judging the nature of the phenomena of the following stage to be treated in the succeeding paragraphs.

The second period, that of descending temperature, commands our close attention. Its consequences may be summed up briefly, but all of the story, perhaps, may never be told. As soon as the cooling process sets in, contraction takes place and there is a great collapse of pressure and inrushing of gases and other volatilized elements of every description. A period of intense chemical activity ensues, comparable to that which must be occurring constantly throughout the marginal atmosphere of the Sun. Such great activity is aided and abetted by: (1) the greatly enriched oxygen content of the air; (2) sufficient kindling temperature present within the area; and, (3) the vacuous condition which aids in the more perfect combusion of gases. This also, in turn, adds to and sustains the intense heat of the phenomenon. Complete oxidation of almost every type of matter present, subject to such reaction, undoubtedly occurs, resulting in the formation of many more or less stable compounds.

While much of the hydrogen, being considerably lighter than air, probably escapes upward by rushing into the atmosphere above, great quantities of it, however, must be sucked back into the region to again unite with free oxygen to form water vapor. It is possible that this theory is borne out by close examination of the picture taken three minutes after the explosion of the bomb at Nagasaki, which indicates the invisible water vapor immediately over the area being condensed into enormous white steam clouds in the colder region above. Far below, next to the surface of the Earth, are what appears to be great masses of the heavier soot, black clouds of carbon, doubtless augmented by many other forms of dust, which have not yet had opportunity to settle to the ground or to be carried upward by ascending air currents. While carbon will burn in ordinary air at moderate temperatures, in its oxygen enriched condition large quantities must recombine with the oxygen to form enormous amounts of carbon dioxide.

Doubtless, there are many other types of reaction which also must take place, depending largely upon the elemental material available at the time. These, it is obvious, are far too numerous to be discussed here at any great length. The presence of certain metallic elements may be indicated by the study of their colored flames, which may, perhaps, furnish us with some evidence of what may be considered to have taken place. While under optimum conditions, carbon burns with a bright blue flame, unconsumed atoms through simple incandescence

may create a yellow luminosity. Many other elements also reveal their true identity by imparting their own characteristic color signature to the flame; for example, the sodium flame is intensely yellow; potassium, violet; calcium, orange-red; lithium, reddish; copper, green; and so on down through a long list of elements.

One other important matter, the consideration of which cannot be ignored at this time, is the possibility of an atomic explosion touching off some sort of a so-called "chain reaction" among the elements of the atmosphere, which might prove sufficiently self-sustaining to so alter the physical composition of the atmosphere to a degree such as to utterly destroy or change most living forms on the Earth. Perhaps, the greatest hazard along this line might come through a realization of the carbon-hydrogen-nitrogen-oxygen chain, with its by-product of helium, which according to Bethe's[6] theory is the most likely source of the enormous energy released by the sun and the stars. Certainly all these elements were present at the time, but, fortunately, it seems nothing so startling as that happened. Whether the elements were not present in the proper proportions or were under insufficient pressure, insignificant when compared to that of the sun or the stars, is an important question. Something apparently was lacking.

That nitrogen does combine with hydrogen of the atmosphere to form ammonia, under such stimuli as the electric arc of chain lightning, we are all well aware, and under the Haber and other successful synthetic processes it is combined in the presence of suitable catalysts, at much lower temperatures and moderate pressures, on a very large scale. This certainly gives us further food for thought. That large quantities of various nitrogenous compounds were formed, there can be little doubt. As these are ideal sources of materials for fertilization, through their introduction of nitrogen into the soil, this type of result is all to the good. Should some future atomic explosion, which we are promised could be made many times more destructive than these earlier tryouts, ever succeed in starting such a self-sustaining chain reaction, that would be all to the bad.

During the third or final phase of the phenomenon, the more serious and lasting effects take place. As we have said before, this is a period of movement and consequence. Great quantities of heat generated by the atomic explosion, tend to expand the air and set into motion huge ascending currents carrying enormous clouds of smoke and dust far into the upper atmosphere. These great chimneys of rising gases are comparable only to those caused by major conflagrations and by the eruption of large volcanoes.

The physical properties and the functional operation of the atmosphere in the process of sustaining life on the planet are so nicely balanced that any action which might tend to destroy this balance becomes a serious menace to all terrestrial tranquility. Grave climatic changes have been brought about, during the past history of the Earth, by

causes which were apparently trivial. We shall discuss at this time the possibilities called to mind by only two or three such realities. An entire paper might readily be devoted to this particular phase of the subject. We do not of course feel that occasional bombings could bring about such disastrous results. We do, however, seriously question the effects which might be brought about by the explosion of large numbers of bombs, such as would undoubtedly be employed in the case of true atomic warfare upon a world-wide scale.

It must be remembered that only a few miles above our heads the temperature of the atmosphere drops rapidly, and, beyond, it soon approaches the intense cold of interstellar space. While warm air ascends, conversely cold air descends, and so, about the area of each atomic explosion large masses of very cold air must eventually come funneling down through the punctured ceiling of the stratosphere to once more establish temperature and pressure equilibrium over the disturbed area. Every meteorologist realizes what vast effects the large, cold, frontal movements which frequently come swooping down from above may have upon existing weather and climatic conditions.

The most profound effect, we believe, however, would be that caused by the cutting off of the sun's radiant energy coming down through the atmosphere, by huge smoke and dust clouds which would be carried upward by the ascending currents. As these clouds drift around the world their interference would be considerable. In this we have almost the exact parallel in the eruption of major volcanoes. Following periods of intense volcanic activity over large areas of the earth, such as must have occurred in late geologic time, as in our Pacific northwestern states, we have evidence that great climatic changes took place.

In studying the movements of the atmosphere two great wind systems are recognized. (1) The lower currents with their cyclonic storms involving elements of the weather, which are more or less local in character; and (2) the upper or planetary system, much too high to be affected by surface conditions, which due to the rotation of the earth upon its axis moves slowly from a westwardly to eastwardly direction in a majestic over-all fashion. It is these later, more highly elevated currents, which transport or carry the major portion of great dust clouds, whether they be of conflagatory, volcanic, or of "atomic" origin. Let us now, for a moment, consider some possible effects.

During the more recent geologic past, great climatic changes came over the earth, bringing about what is known as the Pleistocene Epoch, or the "Great Ice Age," to most of us. During this period, intense and widespread glaciation occurred over large areas in the Northern Hemisphere. As many as a dozen or more theoretical causes have been assigned to account for the coming of the Glacial Epoch. Geologists are not agreed as to the exact cause or causes, as the case may be. Whatever it was, nature finally righted itself, the ice passed away, and conditions on the earth resumed their former state of tranquility.

One of the causes which have been most seriously considered is the effects which the enormous dust clouds connected with the period of great volcanic activity in our northwestern states must have contributed. It so happens that the principal centers of these ice sheets lay in the northeastern part of the North American continent, in about the direct path of the planetary wind from over this volcanic region. Directly, and farther to the eastward in northern Europe, intense glaciation also occurred. This is a good point in favor of the theory that they were at least a contributing factor. If then, in Pleistocene time, great dust clouds, floating in the upper atmosphere, interfering with the incoming rays of the Sun, could bring about major climatic changes producing periods of glaciation, would it not be possible for years of intense atomic bombing, with an attendant disturbance of the balance of the upper atmosphere, to accomplish the same results, perhaps to a lesser degree? I leave it to my readers to decide for themselves. I am simply raising the question and personally hold no arbitrary brief for the theory, however plausible it may sound on the surface. If this should be true, the effects on the earth would certainly be more profound than any mere local destruction of life and property which might result therefrom.

As far as the exterior of the earth is concerned, a single bomb may bring about absolute devastation to some five (5) square miles of surface. This devastation, it must be understood, is mainly not to the Earth itself, but only to surface alterations and the accoutrements of man. Two thousand five hundred (2,500) such bombs, would, therefore, sear only about twelve thousand five hundred (12,500) square miles of territory, or the equivalent of an area one hundred by one hundred and twenty-five miles in extent. This effect for the most part would probably be only temporary, and even should it be permanent, an area no larger than a small-sized desert would be thus affected. When compared to the total surface of the entire earth, which is stated to be 196,940,000 square miles, we find this to be approximately one fifteen-thousandth of the whole, which, as a matter of fact, seems quite inconsequential. Properly placed, however, these bombs might readily wipe out some fifteen per cent of the world's population, but here again, it must be remembered, "Old Father Time," in his own inexorable manner, without much ado, accomplishes the same end about once every ten years, while in about the same period a like amount of physical depreciation of human property takes place, and little or nothing is ever thought or done about it.

Coming back now to the matter of the atmosphere itself, a disturbance of hemispherical volume three miles in diameter would involve some ten (10) cubic miles per bomb, or a grand total of some twenty-five thousand (25,000) cubic miles for twenty-five hundred (2,500) bombs. Considering only the lower twenty (20) miles of the atmosphere, which seems to be of fairly uniform consistency, for the whole

earth we have a matter of some 4,000,000,000 cubic miles of air,—and were all these bombs to let go simultaneously, only a trifle over six parts per million of the Earth's atmosphere would thereby be disturbed. Regardless of the serious consequences for the instant, in the immediate vicinity of the explosion, it is difficult to perceive that there could be any far-reaching or permanent effects resulting therefrom upon the final dissipation of all these gases and forces throughout the entire atmosphere.

Again, considering the problem from an entirely different angle, in so far as intense heat and other forms of energy which might be generated by any such multiple explosions are concerned, as tremendous as these forces may appear at the time, they can scarcely equal the total amount of the Sun's radiant energy, which would be simultaneously received upon the surface of the planet. Likewise, we may also be certain, that, they could hardly be compared to many of the greater cataclysmic events of nature which have so often beset the Earth during its past rugged geologic history.

It should be also observed, that the deductions herein stated may not account precisely for, or coincide with certain of the phenomena described by eye witnesses. That they should do so is inconceivable, as there are many unknown factors yet to be explained. However, it is hoped, that these remarks may at least open and lead to a general line of thinking and discussion which may eventually give us a more perfect understanding of many phases of the problem than otherwise would have been possible. In this respect, let no one feel that the author believes this to be the final word on the subject. It is only the beginning.

And so, in conclusion let us state that we feel, in the light of all these reassuring facts, that we may safely assume the consequences of the momentous discovery of these new sources of tremendous energy developed by atomic fission to be more political than physical. The writer is sincere in his belief that such is the case. If, however, should future developments prove him to be wrong, we have this one consolation,—none of us will ever know it, for total extinction via the route of atomic disintegration would certainly be delightfully instantaneous.

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Status of the Planetary Nebulae

By CHARLES DILLON PERRINE

"The hypothesis that the *Planetary Nebulae* have been the forerunners of solar systems has been considered favorably by astronomers. Campbell." (*The Scientific Monthly,* October, 1915, p. 11.) This belief is not unnatural based as it is on the appearance of these objects and the indisputably primitive state of the material composing them. Nevertheless it is not tenable when other pertinent facts are taken into account—facts which show conclusively that these nebulae are stabilized novae incapable of forming planetary systems.

In the first place we have the crucial test of the moment of momentum as in the case of our solar system where the major planets could not have resulted from condensation or from *rings,* considerations which at once wrecked Laplace's *Nebular Hypothesis.* Many of the planetary nebulae have irregular, more or less isolated, masses of matter within their structures but all have effective rings or shells and some are almost wholly in a *single* ring or shell, an outstanding example of which is the great *Ring Nebula* in Lyra. Another obvious objection is that the numerous and widely dispersed planets of our solar system could not have been formed from *rings,* much less from a *single ring.*

A further and crucial difficulty is that the planetary nebulae are effectively *spherical* and not the *thin discs* which would be requisite to the formation of planetary systems confined to a nearly mathematical equatorial plane. A generally spherical form of the planetaries is established also by line-of-sight velocities on opposite sides of the nucleus which have been observed in some. A spherical form is also a necessary consequence of the explosive, expanding outburst in a nova.

Campbell has adverted to another fact which while not seriously in opposition, perhaps, nevertheless is not to be expected from the solar system hypothesis advocated by him. It is the *small number* of the planetaries, a fact which, however, finds adequate explanation in the status of these bodies as stabilized novae.

Extensive experience and interest in the novae beginning with Nova Persei No. 1 of 1901 has impressed me with the significance of a number of facts, chief of which are:

1. The appearance (of galactic novae) only in or near the *Milky Way* where cosmical matter is plentiful.
2. Their ephemeral nature.
3. The expanding shells of nebulosity about them.
4. Irregular masses of nebulosity within and especially as appendages to the novae.
5. Spectrographic observations which indicate that these nebulosities shine by reflected light.

6. That before the outburst such stars are faint and have *late type* spectra, a condition which returns within months or a few years.

7. Extensive nebulosities about bright *early type* stars, also shining by reflected light.

It is not necessary to discuss in detail the phenomena of the novae but merely to give without comment the above facts of observation, their bearing directly on the status of the planetary nebulae being obvious.

There is one outstanding difficulty between planetaries and novae, however, which is marked but which is believed to be more apparent than significant—the time element. The planetaries have shown no certain changes in the years, some of them a century or more, since they have been under observation, whereas the novae have gone through their cycles from faint, late type to the outburst and back again to faint, late type, in a very few years or even months. This difference is believed to be merely one of magnitude of the outburst. All of the other and numerous factors are so in accord and so definite as to leave no doubt of the community of origin. The apparent fixity of the planetaries may, and probably will, disappear with observations over longer intervals, revealing slow returns to normal or to matter in a different form.

Differences in the time element must result from the mode of the novae outbursts—which is the collision of a small cloud of cosmic matter with a faint late-type star—the greater the amount of matter in the impinging cloud the greater the outburst and the slower the return to the star's normal condition even to the stabilization of any phase over long intervals. Other objects such as the *Crab Nebula* in *Taurus* are believed to be such more or less stabilized outbursts.

The evidence is so strong both in amount and character, and without contradiction, that we must consider the planetary nebulae as the more or less stabilized results of novae outbursts, and for the reasons given incapable in general of forming planetary systems like ours.

The objection to a solar system hypothesis of the planetary nebulae is also strongly upheld by the fact that the normal spectral type of the novae is *late* type, both before and after the outburst instead of the G-type which appears to be a requisite of planetary systems, at least of those where human life can flourish.

In this connection the fact should be stressed that novae outbursts occur only about stars of the *latest types* or where no star was known, never about stars of *early type with high radiation*. This fact alone is almost sufficient to establish collision with cosmical matter, as such matter could not be attracted to a collision by the high light pressure of such stars, but only where light pressure is weak as in late-type stars, or absent as in dark stars. Light pressure accounts also for the fluctuations after the main outburst.

Furthermore, a number of bright *early-type* stars have clouds of such

matter as appendages, shining by light reflected from the star, but no such appendages are known about bright *late-type* stars.

What becomes of the matter ejected in the outbursts is not so clear but the most probable course is that most of it is ejected in gaseous form beyond the control of the central star where it condenses into and is added to the cosmical matter which is known to be so plentiful in interstellar space.

That which is not ejected beyond the star's gravitational control is condensed into finely divided solid matter to disappear from observation and be absorbed slowly by the primary if not so finely divided as to be held off by light pressure or ejected into space by the same force—consequences which will vary with the star's radiative condition.

It may be argued by some that there may be other ways by which a planetary nebula can become a planetary system. To this it is only necessary to say that the status suggested rests upon known facts and laws and is sufficient.

VILLA GRAL. MITRE (TOTORAL), CÓRDOBA, OCTOBER 12, 1948.

Baron von Zach and his Astronomical Correspondence

By ANGUS ARMITAGE, F. R. A. S.

As the eighteenth century drew towards its close, there occurred throughout western Europe, and notably in Germany, a marked growth in the number and influence of journals dealing with contemporary developments in science.[1] The earliest publications of this kind tended to cover the whole field of science, and, indeed, to embrace much else besides. But the growth of specialization was eventually reflected in the appearance of the class of journal which is exclusively devoted to one science only.

To the student of astronomy, the genesis of the typical astronomical journal must be of particular interest. It was not an entirely new creation, but rather an independent embodiment of older forms of expression. Two principal constituents can be distinguished, deriving respectively from the *learned correspondence* and from the *ephemeris,* or almanac, of earlier generations.

The pioneers of modern astronomy,—notably Tycho Brahe, Kepler, and Galileo,—maintained with their contemporaries an extensive correspondence as the only available means of propagating their ideas and of learning about one another's work. From the latter part of the seventeenth century onward, the transactions of the great scientific academies were open to receive astronomical papers and observations for publication. In due course, also, there appeared the "omnivorous" scientific journals to which reference has already been made. In these

media, however, astronomy had to compete for space with the other rapidly developing sciences, while purchasers of these publications had to pay for much that did not particularly interest them. The printing and distribution of the academic transactions were sometimes delayed for years, and the contents were often in vernacular languages which foreign scholars could not comprehend.

It was with a view to overcoming these disabilities that, in 1733, the German astronomer Michael Adelbulner of Nuremberg (acting on a suggestion from the Swedish scientist Celsius) invited astronomers everywhere to co-operate in the establishment of a periodical consisting primarily of letters of purely astronomical interest sent in from all quarters.[2] It was to appear monthly, in Latin, and to be promptly distributed for sale at the modest price of a florin a copy. The journal was started on these lines in 1734, but it ran for only five years. Later on, in the seventeen-seventies, Jean Bernoulli "the Third," one of the younger members of his illustrious family, conducted for a time what was intended to be an astronomical annual.[3] It was printed in French, and it contained short memoirs, original or in translation, abstracts of important papers of the preceding year, notices of forthcoming books and astronomical news of all kinds. Of this review, which appeared at rather irregular intervals, only three volumes and some supplementary material were published.

The second principal root from which the astronomical journal sprang was the ephemeris, a characteristic type of publication going back at least to the era of the invention of printing. It tended to become a periodical because celestial phenomena are predictable but are never the same for two years in succession. Hence an astronomer, having brought out an acceptable almanac, was encouraged to repeat the performance over a series of years, thus producing a sequence of annual volumes. It was also natural that the bare bones of the ephemeris should be clad with descriptive matter of interest to readers. In earlier days, this matter would relate to the supposed astrological import of the phenomena predicted. With the rise of a more rationalistic attitude to nature, however, the notes became scientific in content, their occurrence in successive yearly instalments thus constituting a species of journal.

The emergence of the astronomical periodical as a by-product of the almanac may be illustrated by reference to a famous eighteenth century ephemeris, the Yearbook started by the German astronomer J. E. Bode in 1776.[4] This has continued to appear without interruption down to the present day, though with several changes of title, and with the descriptive notes long since suppressed. In the earlier volumes we find, besides an almanac on traditional lines, miscellaneous notes and communications edited by the German physicist J. H. Lambert.

To detach the descriptive from the tabular matter of the typical ephemeris for separate publication in an organ serving also for the epistolary

interchange of information, was the one further step needed to bring the independent astronomical journal into being. It was taken by one of the regular contributors to Bode's Yearbook, the Hungarian astronomer Baron von Zach.[5]

Franz Xaver von Zach was born at Pesth, the Hungarian capital, in June, 1854 (the exact date of his birth is in dispute). His father seems to have been a distinguished physician of that city who had been raised to the nobility. Franz was educated at a Jesuit seminary, where he acquired a good knowledge of mathematics. His interests are said to have been turned to astronomy through observing the transit of Venus of 1769 and also a comet which appeared in that year. He taught himself the elements of the science from Lalande's *Astronomie*. As a young officer of engineers in the Austrian army, Zach was engaged upon the national survey, and thus became familiar with the technique of astronomical observation. Having retired from the army, he was appointed Professor of Mechanics at Lemberg (now Lwow). However, following the death of the Empress Maria Theresa in 1780, her successor, Joseph II, suppressed the Chair on grounds of economy, while promising to appoint Zach to the next suitable vacancy. Tired of waiting for dead men's shoes, Zach decided to seek his fortune abroad. He traveled through Italy and France and eventually arrived in Paris, where he became well acquainted with Laplace and Lalande, and seized every opportunity of perfecting his knowledge of theoretical and practical astronomy. Zach used to attend the meetings of the Academy of Sciences, adjourning thence with a small group to take part in informal discussions and experiments.

Towards the end of 1783, Zach migrated to London. Here he met the great Herschel, illustrious from his recent discovery of the major planet Uranus; also Nevil Maskelyne, the Astronomer Royal; Sir Joseph Banks, the naturalist and President of the Royal Society; Jesse Ramsden, the instrument maker, and the horologist, Thomas Mudge (the elder) and Josiah Emery. In London, too, Zach met Count Moritz von Brühl, the ambassador of the Elector of Saxony. The Count was impressed by the erudition, and attracted by the agreeable disposition, of the young Hungarian astronomer, who soon became attached to the Brühl household as a devoted friend and as tutor to the children. Brühl was a keen amateur astronomer, and he had built for himself a small observatory in the West End of London (Dover Street, Piccadilly) where he and Zach used to observe together. One of Zach's communications to Bode's Yearbook describes a night which he and the Count spent observing with Herschel at Datchet.

In 1784, Brühl and Zach paid a visit to the Count's stepson, George Wyndham, the third Earl of Egremont, at his country house of Petworth in Sussex. It was there that Zach made the interesting discovery of a collection of scientific papers of Thomas Harriot, the Elizabethan mathematician, a friend of Sir Walter Raleigh and a pioneer in the

application of the telescope to astronomy. Use was subsequently made of Harriot's recorded observations of sunspots by Rudolf Wolf in the course of his own classic studies on the periodicity of these phenomena. The discovery of the Harriot papers also helped indirectly to shape the destiny of the great German astronomer, F. W. Bessel. He applied the improved method of computing cometary orbits, devised by Heinrich Olbers of Bremen and published by Zach at Weimar in 1797, to Harriot's observations of the apparition of Halley's comet in 1607 which Zach, again, had brought out in 1793 in a supplement to Bode's Yearbook. Bessel's calculations, published by Zach in 1804, were warmly received, notably by Olbers, which largely decided Bessel to devote his life to astronomy. Zach formed the intention of publishing Harriot's scientific papers in their entirety, but unfortunately he never found opportunity to do so, and they still await an editor.

In 1785, Zach accompanied Count von Brühl on a visit to the latter's home in Dresden. They went by way of Brussels and Frankfort, determining the longitudes and latitudes of all three cities by means of a chronometer (made by Emery and showing Greenwich time) and a Hadley's sextant for finding the Sun's meridian altitude and the local time. Zach was one of the first to appreciate the possibilities of the sextant in fundamental geographical work, and to instruct travelers, including Humboldt, in the use of the instrument. The return journey to London was made by way of Paris, the longitude of which from Greenwich was similarly established.

Count von Brühl was a trusted friend of the reigning Duke of Saxe-Gotha, Ernst II (1745-1804), who had succeeded to the duchy in 1772. Like his ancestors since the days of Ernst "the Pious," the Duke was a generous patron of the arts and sciences in his little domain.[6] He was himself an adept in experimental physics, with a well-equipped laboratory in his castle of Friedenstein, whither the poet Goethe used often to repair to watch the experiments and sometimes to borrow the instruments. However, his main scientific interests lay in astronomy, and he conceived the plan of establishing an observatory in the neighbourhood of Gotha. It was to Moritz von Brühl that he turned in 1785 for advice about equipping this institution. Brühl offered to procure a suitable telescope from Herschel, whose instruments were by now in great demand all over Europe. At the same time he inquired if the Duke had yet selected a suitable astronomer to direct the new enterprise, indicating that he had an admirable candidate in mind. In a subsequent letter, Brühl mentioned Zach by name and briefly recounted his life-history. Terms were agreed upon between the correspondents, and Zach arrived at Gotha on June 22, 1786, accompanied by his pupil, Brühl's son, who was still in need of his care.

The mountain peak of Seeberg, near Gotha, was chosen as the site of the new observatory, and it fell to Zach to draw up the plans, while the Duke set off for England to order the necessary instruments. The

observatories of the eighteenth century were still mostly of the old-fashioned watch-tower type, and the design of Seeberg was based upon that of the Radcliffe Observatory at Oxford. Work upon the new building was, however, delayed for some months, the ill-health of the Duchess necessitating a prolonged tour to the south of France on which Zach accompanied the ducal party. He assisted in determining the longitudes and latitudes of the cities through which they passed, and in establishing and operating a temporary observatory at Hyères. Following the return to Gotha late in 1787, the meridian line of the new observatory was determined and the foundations were laid. While awaiting the completion of the building, the Duke and his astronomer observed from the eastern wing of Friedenstein Castle, whence an uninterrupted view of the meridian could be enjoyed. Following the inauguration of the Seeberg Observatory in 1792, their joint activities continued until the death of the Duke in 1804.

Seeberg Observatory was built massively of native stone and was divided into five compartments ranged side by side, the central one being surmounted by a tower with a revolving dome. Two wings to the building afforded living apartments for the staff. The instruments installed there included a transit-circle (Jesse Ramsden's master-piece); also a Dollond achromatic 4-inch refractor, a zenith-sector and a pendulum clock. Ramsden did not live to complete two mural quadrants that had been ordered. Zach secured the maximum stability for his fundamental instruments by mounting them upon piers of porphyry which in turn were based upon the bed-rock of the mountain. One of the early visitors to Seeberg was the Prague astronomer, Father David, who has left a detailed account of the instruments and methods in use there.[7] He describes Zach's ingenious optical arrangement for taking transits with his right eye on the star and his left eye on the clock! The observatory came to be regarded as the best in Germany and as fit to stand comparison with any in the world. It was a training-school for young astronomers, several of whom won subsequent distinction. Among the many distinguished visitors to Seeberg was J. J. de Lalande, the doyen of French astronomers, who arrived in the summer of 1798. Despite the fact that he hailed from Red France, and was suspected of interest in other revolutions than those of the heavenly spheres, many German astronomers gathered to do him honour, thus constituting one of the earliest of all scientific congresses. During the ten days of its continuance, matters of common interest were discussed, such as the use of mean time, the adoption of the metric system for scientific purposes, and the demarcation of new constellations in the southern heavens. Novel types of astronomical instruments were demonstrated, so far as the bad weather permitted.

It was in 1798, the year of the Seeberg Congress, that Zach entered upon his career of scientific journalism with the establishment in Weimar of his monthly *Geographical Ephemeris*.[8] It was produced by

the cooperation of an international committee of experts; it provided the reader promptly with news of the latest developments in astronomy and geography and with especially written articles promoting these sciences, and it served as a clearing-house for observations helping to determine the longitudes of places. There were also reviews of new books and maps, with reproductions of the latter, "statistical" articles (in the old sense of the word as applying to descriptions of countries), and portraits of leading scientists of the day. However, the task of editing this periodical made too great demands on Zach's time, and in 1800, with the conclusion of the fourth volume, he handed it over to be continued by A. C. Gaspari and F. J. Bertuch in a form no longer appealing directly to astronomers. In its place, Zach started his *Monthly Correspondence* (*Monatliche Correspondenz*),[9] with which his name is particularly associated.

This new periodical was designed to continue certain features of its predecessor, but it was planned on less formal lines and was based upon an even more extensive correspondence. The progress of astronomy in the various European countries was surveyed from time to time, activities in France, for example, being summarized in letters from Lalande. Important memoirs such as those of Herschel were translated into German; new books were reviewed, novel instruments and methods were appraised. Zach contributed biographies and obituaries of leading astronomers, and an astronomical diary giving the results of his travels and determinations of position all over Germany. The exciting episode of the discovery, and the establishment of the true status, of Ceres, the first known minor planet, can be followed in the early volumes of the *Correspondence*. It illustrates the vital role of that journal, which Lalande described as "the *depot* of astronomy for every part of Europe." It was to Zach that the various reports were sent in of Piazzi's discovery, on the first evening of the nineteenth century, of a mysterious object soon to be lost in the Sun's glare. He was among the first to suspect that it was the long sought planet, bridging the disproportionate gap between the orbits of Mars and Jupiter, for which a committee of astronomers (with Zach as secretary) had already resolved to search. And when Gauss, by a novel technique, had computed the orbit of the asteroid, it was Zach who was the first to pick it up with his telescope when in due course it became visible again. It fell to Zach, also, to confirm Olbers's discovery of a second minor planet, Pallas.

Zach's *Correspondence* makes good reading even today. On the other hand, most of his formal publications consist of books of tables which now chiefly serve to illustrate the condition of fundamental astronomy just before it was revolutionized by Bessel. In those days each astronomer had his own methods and arbitrary standards for reducing the apparent places of celestial bodies to their mean place under specified conditions. Zach's tables were designed to ease the laborious calcula-

tions involved in correcting piecemeal for precession, nutation (lunar, but not solar), aberration, etc. Along with his tables, he published from time to time his determinations of the right ascensions of the principal stars. Lalande considered Zach's values the best available, and he supplemented them with the corresponding declinations which he had himself obtained at Paris with the meridian circle of the École Militaire.

In 1802, Zach was entrusted by King Frederick William of Prussia with the trigonometrical survey of Thuringia. With this undertaking it was intended to combine the determination of the respective lengths of a degree of arc measured along, and at right angles to, the meridian, so as to test the accepted theory of the figure of the Earth. However, the enterprise was interrupted by the outbreak of war between France and Germany, and by the death of Zach's patron, Duke Ernst II. This latter event unfortunately marked the end of Zach's intensive professional activity as an astronomer. For now he was appointed Chamberlain to the widowed Duchess, and accompanied her for many years upon her restless itinerations about Europe in pursuit of health. However, Zach was indefatigable in setting up temporary observatories wherever the party came to a halt, and in collecting astronomical information from any libraries to which he could obtain access. To this period also belongs his book, published at Avignon in 1814, and of some importance in its day, on the deflection of the perpendicular in the neighbourhood of massive mountains, produced by their gravitational attraction.

Upon leaving Germany, Zach had been succeeded as Director of Seeberg by his friend and assistant, Bernard von Lindenau; subsequently the office was held in turn by two of Gauss's pupils, J. F. Encke and P. A. Hansen. It was during Hansen's term of office that the original observatory was dismantled and re-erected in a less exposed position in Gotha.[10] The *Monatliche Correspondenz* was handed over to Lindenau in 1807, though it continued to bear Zach's name as editor until 1813, when Lindenau left to fight against Napoleon. Zach then allowed it to cease publication with the intention of starting a similar periodical at Genoa, where he had by now settled. This new *Correspondence*[11] was published in French in the hope of securing a wider circulation. It appeared from 1818 to 1826, and ran into fourteen volumes. The outside contributors were as distinguished as ever, but Zach's own papers do not seem to have been prepared with quite his former care amid the distractions of his other duties, and his increasingly caustic criticisms gave offense to some of those against whom they were directed. Zach's mantle may be said to have fallen upon H. C. Schumacher, the founder of the celebrated *Astronomische Nachrichten*.

The death of the Duchess in 1827 marked the close of this chapter in Zach's varied career. His departure from Italy was hastened by the hostility of the Jesuits (aroused by his openly avowed free-thought), and by the onset of a painful malady which had already brought his

journalistic activities to an end, and from which he could obtain relief only by treatment at the hands of a famous Paris physician. His health improved sufficiently for him to return to Germany for a time, where he lived in Frankfort with his friend and successor Lindenau. However, a relapse at the end of 1828 drove him back to Paris. An epidemic of cholera, breaking out in the city, claimed Zach as a victim on September 2, 1832. He lies buried in Père Lachaise. His place in the history of astronomy may be well described in the words written of him, years before, by Lalande: "No living astronomer has been of greater service to the progress of astronomical science."[12]

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Meteorites in as well as on the Crater Rim

By H. H. NININGER

While working under a permit from the Standard Iron Company (owners of the Arizona meteorite crater) the American Meteorite

Museum began several investigations designed to add to the fund of scientific information regarding the nature of the event which produced this great phenomenon.

One of these projects was to ascertain the vertical distribution of meteorite fragments in the blanket of ejecta which covers the uplifted rim surrounding the pit.

At various points on the rim were found numerous trenches two to three feet in depth which we presume to have been dug during the early explorations carried on by Dr. Barringer and his various associates. Considerable piles of the out-throw from these excavations were still in place and we decided to inspect them as a means of ascertaining whether meteoritic material was disseminated through the deeper layers as well as in the surface layer.

We had been unable to find any record showing whether or not meteorites had been recovered at the time these particular trenches and pits were dug. Of one thing we could be certain, namely, that as erosion removed the tops of the diggings subsequent to their abandonment, any exposed fragment of metal would certainly have been picked up by collectors who have again and again combed the surface of the area during the past two decades.

We were also aware that much of the rim had been subjected to search by various collectors using sundry detecting devices and we could not be sure that the dumps had not been explored by such means. However, visual inspection showed no evidence of digging. Consequently, we decided to go over them with our instrument.

The instrument used was an M 625 war-surplus mine detector. Tests showed that this instrument would detect a two-pound metallic meteorite at a depth of 24 inches. Nearly all of the diggings from the trenches were less than this depth.

Altogether, we explored about 20 cubic yards of diggings and in this volume of material we recovered 67 metallic meteorites averaging about one-half pound weight. In addition to the metallic material we recovered about the same weight of oxidized meteorites. Since these oxides contain approximately 60% by weight of metal (recoverable by smelting) the total weight of meteoritic substance recovered from 20 cu. yd. of diggings was 53.5 pounds.

Our permit expired before we had opportunity to complete this type of investigation as we had planned it. But in connection with present construction operations an excellent opportunity is afforded to carry out a much more extensive exploration. It is hoped that those in charge are not overlooking this opportunity and that further light may thus be shed on this problem.

American Meteorite Museum, Winslow, Arizona.
June, 1949.

The Planets in September and October, 1949

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. The sun's autumnal migration toward more southerly declinations proceeds most rapidly during this period, so that it will stand more than 14 degrees south of the equator at the end of October. Its crossing of the equator, called the autumnal equinox, will occur on September 23 at 3 A.M.

Moon. The phases of the moon will occur as follows:

Full Moon	September	7	4 A.M.
Last Quarter		15	8 A.M.
New Moon		22	6 A.M.
First Quarter		28	10 P.M.
Full Moon	October	6	9 P.M.
Last Quarter		14	10 P.M.
New Moon		21	3 P.M.
First Quarter		28	11 A.M.

The moon will be at perigee on September 22 and on October 21.

A total eclipse of the moon, the second for this year, will be generally visible on the evening of October 6. The moon will enter the shadow of the earth at 7:05 P.M., and by 8:20 P.M. will be completely immersed in it. This total phase will last 1 hour and 14 minutes.

Evening and Morning Stars. The two brightest planets, Venus and Jupiter, will shine in the evening sky, while Mars, much fainter, may be found in the eastern sky before dawn.

Mercury. Mercury will be visible in the evening sky during the first two weeks of this period, since it will be at maximum eastern elongation on September 7. Then, during the last two weeks of October, it will be a morning object, being at greatest western elongation on October 19.

Venus. This brightest planet will always be visible up to two hours after sunset, but its increasing southern declination will result in poor altitude conditions.

Mars. Mars' position near Regulus in the morning sky, where it will appear as a red star of not quite first magnitude, will be increasingly favorable. It will be rising at about 2 A.M.

Jupiter. Since it will be near the meridian in the early evening, Jupiter will be most convenient to observe during this period.

Saturn. Conjunction with the sun on September 2 will preclude its visibility during that month. However, Saturn will return to visibility in the October dawn, rising at 3 A.M. by the end of the month.

Uranus. Uranus will be stationary on October 11, at about a degree north-northwest of μ Geminorum.

Neptune. Since it will come to conjunction with the sun on October 8, Neptune will be practically unobservable during this period.

Department of Mathematics, Temple University, Philadelphia, Pa.,
July 4, 1949.

Occultation Predictions for September and October, 1949

Date 1949	Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′										
Sept. 4	40 B.Capr	6.2	2 30.1	—2.6	—0.5	109	3 30.8	—0.7	+1.1	201
5	33 Capr	5.5	2 10.0	—1.8	+1.1	60	3 35.4	—1.7	+0.4	241
10	ζ Pisc	5.6	8 41.9	—2.1	—1.1	90	9 47.1	—0.7	+1.8	198
10	BD+6°175	6.5	8 43.5	—2.1	—1.1	91	9 48.0	—0.7	+1.9	198
14	χ Taur	5.5	9 13.1	....	....	9	9 57.7	—3.0	—3.6	310
17	BD+27°1337	6.4	7 36.1	—0.8	+0.6	114	8 37.3	—0.7	+2.2	244
Oct. 3	29 Aqar	6.5	4 11.3	—1.3	—0.3	66	5 23.4	—0.5	+0.2	223
10	ζ Arie	5.0	7 31.3	—1.4	+2.3	34	8 46.5	—1.9	—1.3	275
13	406 B.Taur	5.6	5 1.0	—0.8	+1.3	93	6 9.8	—0.8	+2.1	241
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Sept. 4	40 B.Capr	6.2	1 47.2	—1.9	+0.7	98	3 4.7	—1.7	+1.2	223
4	56 B.Capr	6.3	7 17.6	+0.5	+1.4	13	8 1.3	—1.3	—2.3	291
5	33 Capr	5.5	1 35.6	—1.5	+1.8	53	2 56.7	—2.0	+1.0	260
10	ζ Pisc	5.6	8 1.8	—2.0	+1.0	64	9 25.4	—1.2	+1.5	214
10	BD+6°175	6.5	8 3.3	—2.0	+1.0	64	9 26.2	—1.2	+1.6	214
17	BD+27°1337	6.4	7 26.2	0.0	+1.0	96	8 24.9	—0.2	+1.5	259
30	234 B.Sgtr	5.9	3 33.6	0.0	+0.9	22	4 22.2	—1.8	—2.3	299
Oct. 3	29 Aqar	6.5	3 45.9	—1.3	+1.1	38	5 5.4	—1.6	—0.2	248
10	ζ Arie	5.0	7 5.6	—0.2	+3.9	9	8 3.3	—3.1	—1.2	288
11	36 Taur	5.7	5 57.3	—2.3	+0.2	113	6 47.7	0.0	+4.0	192
13	406 B.Taur	5.6	4 50.9	0.0	+1.6	73	5 53.3	—0.5	+1.5	260
27	*b* Sgtr	4.6	22 50.2	—2.9	—1.5	140	23 24.8	—0.7	+2.6	188
Occultations Visible in Longitude +98° 0′, Latitude +31° 0′										
Sept. 4	40 B.Capr	6.2	1 29.2	—1.7	+0.2	115	2 36.2	—2.1	+2.2	213
4	56 B.Capr	6.3	7 7.4	—0.2	+1.1	28	8 7.8	—1.2	—1.2	273
5	33 Capr	5.5	1 9.5	—1.3	+1.6	69	2 31.8	—2.0	+1.4	250
10	ζ Pisc	5.6	7 35.9	—2.4	+1.3	70	8 58.0	—1.0	+2.6	202
10	BD+6°175	6.5	7 37.2	—2.4	+1.3	70	8 59.0	—1.0	+2.6	201
14	χ Taur	5.5	8 26.3	....	....	351	8 50.8	....	....	315
15	354 B.Taur	6.3	10 12.8	....	....	18	11 4.0	—3.5	—2.4	308
30	234 B.Sgtr	5.9	3 22.2	—0.8	+1 0	33	4 26.2	—1.9	—1.5	285
Oct. 3	29 Aqar	6.5	3 23.6	—1.7	+1.6	42	4 51.5	—1.9	+0.6	241
10	ζ Arie	5.0	6 31.8	—0.4	+3.1	21	7 44.8	—2.9	+0.4	269
11	36 Taur	5.7	5 41.7	—3.2	—1.1	127	6 12.3	....	....	174
13	406 B.Taur	5.6	4 39.9	+0.2	+1.1	82	5 37.9	0.0	+1.5	250
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Sept. 5	ε Capr	4.7	10 7.4	—2.6	—3.5	119	10 39.1	+1.2	+3.2	177
10	ζ Pisc	5.6	7 19.1	—0.3	+2.8	15	8 26.6	—2.4	+1.1	262
10	BD+6°175	6.5	7 20.1	—0.3	+2.8	15	8 28.2	—2.4	+1.1	262
12	36 Arie	6.5	8 5.2	—1.2	+1.6	77	9 16.4	—0.7	+2.6	210
26	64 G.Libr	5.7	0 50.7	—1.6	—1.8	144	1 54.9	—1.4	—0.8	259
Oct. 3	29 Aqar	6.5	3 12.3	+0.1	+4.5	350	3 43.0	—4.5	—1.7	308
11	36 Taur	5.7	5 25.3	—0.1	+1.6	71	6 28.3	—0.3	+1.9	238

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to

the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

As the second half of the year comes nearer, attention should be called to the fact that nearly all of the few really prominent annual meteor showers appear between late July and the middle of December. So far as moonlight is concerned the Delta Aquarids, with maximum about July 28, this year should be seen under ideal conditions, but for the far more numerous Perseids, as the Moon is full on August 8, they could hardly be worse. However, as there are usually a good many bright Perseids we hope that our members will make proper efforts to secure observations on several nights near maximum. Incidentally, the Perseids have already begun their activity when the Delta Aquarids are appearing, so good Perseid radiants should be obtainable in the second half of the night from at least July 26 to August 5, without much interference from moonlight. The Moon will be new on Oct. 21, Nov. 20 and Dec. 19. Hence conditions are ideal for the Orionids and very good for the Leonids and Geminids, though for the former, as the dense part of the stream is near aphelion, we can hardly expect a high hourly rate. Still they should by all means be observed carefully.

Wolf Creek Crater Australia

Thanks to our member, J. Fraser Paterson of Broken Hill, Australia, a copy of the February, 1949, number of "The Conveyor" has reached me. This contains an article on the Wolf Creek Crater illustrated by two airplane photographs. The latter have a most striking likeness to many taken of the Arizona Meteorite Crater, with the exception that we find a considerable number of trees growing in the inside. The estimated size of the new crater is given as 150 feet deep and 2800 feet in diameter, the rim being from 60 to 100 feet above the surrounding plain. It seems almost absolutely circular. It is pointed out that the crater lies well off the regular lines of air travel, and in a region which prospectors and station riders had no reason for visiting. Also from the outside, the rim looks like an ordinary hill, with nothing distinctive about it. Indeed its discovery makes one wonder how many others exist in little explored areas, especially as in densely wooded regions such formations would be very difficult to detect, much more so than on a flat semi-desert.

Messrs. R. S. Matheson and D. J. Guppy, in charge of a Commonwealth Party, reached the crater in late August, 1948, and apparently spent two days there surveying and collecting. On the southern rim they say small fragments of ironstone were picked up which they believed were of meteoric origin. Evidently, in such a brief time, no adequate study of the formation could have been made and presumably no digging whatever was attempted. It is to be hoped that a fully equipped expedition, which can spend the necessary time on the spot, will soon be sent. However, the men mentioned submitted their samples to the W. A. Chemical Laboratories for analysis and gave the writer of the article, Frank

Reeves, a fragment. This latter was sent to R. O. Chalmers, Curator of Minerals of the Australian Museum in Sydney, who has specialized in Australian meteorites. The latter stated that the fragment of ironstone submitted is definitely of meteoric origin. This verdict adds much probability to the impact theory of origin for the crater, which is further aided by the absence, so far as I can learn, of any volcanic formations within a great distance.

METEORSTRÖME

Just this week a book on meteors has arrived from Germany entitled "Meteorströme," written by the man who, in my opinion, knows more about meteoric astronomy than anyone in his country, namely Prof. Cuno Hoffmeister. In some future Notes, I hope to rather fully review this book which is 286 pages long and has the most excellent innovation of English résumés of some length at the end of each chapter. But I wish to call attention to it at once, so that copies may be ordered, without delay, by the many in this country who will wish to study it. It is published by Verlag Werden Und Werken, Weimar, Germany.

Contrary to our usual custom, I am including a paper in these Notes, written by one of our members, entirely on his own initiative. While a slight amount of editing has been done, it stands essentially in the author's own words and expresses his conclusions which do not, in every respect, agree exactly with my own opinions. It, however, though based upon only a fraction of the data which for instance, would be available to a person in residence here or at some of the larger observatories, represents an earnest and successful attempt to reach results of value in meteoric astronomy, and doubtless cost the author very much time and effort. It also points out where there is the need of even better data than now exist, if more certain conclusions are to be reached. For these reasons, which I consider adequate, the paper is being incorporated in these Notes without my assuming responsibility for all the conclusions to the same extent as I would were it written by a member of my own staff.

Since our annual report for 1948 was published in the March Notes, more observations have arrived from E. M. Brooks, D. E. Griswold, Prof. Mohd. A. R. Khan, E. O. Oravec, and J. H. Schilling. All will be fully reported upon in due time, but I should like to say at once that Prof. Khan's report of 417 meteors on 22 nights, added to the 564 already reported earlier, ran his total for the year to 981. During the first half of December he made regular observations on every night from Dec. 1 to 14 inclusive, plotting 357 meteors. This series should permit a unique study of the richness and radiants of the Geminid stream, as I do not believe that a comparable series exists by any one man, for a given year, over the whole period mentioned. Indeed, his contributions to meteoric astronomy for the past decade or so have been outstanding, especially as, until Mr. P. Barnes began to report a year or two ago, Prof. Khan was to my knowledge the only man in all of India who did regular meteor work. Now that we have two most active observers there it will be of great interest to compare rates from Lyallpur in Long. 73° E and Lat. 31° 30′ N with those at Begumpet, which is in Hyderabad in central India.

The Annual Variation of Non-Shower Meteors

By JOHN DAVIS BUDDHUE
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For a number of reasons, which may be discussed at length some other time, it appears to the author that there are three classes of meteors which differ

in their origins. It is the purpose of this paper to show the annual variation of meteors after the members of two of these classes have been eliminated in so far as possible.

One class of meteors is composed of those that accompany all of our fallen meteorites, whether recovered, or observed to fall, or not. Von Niessl and Hoffmeister have derived hyperbolic orbits for some of these, but there is reason to believe that the data upon which their calculations are based contain systematic errors of a type which would lead to this result.[5] Many other calculations lead to elliptical orbits that are not very different from those of asteroids. This fact, coupled with their chemical composition, leads to the belief that they are, and always have been, members of the solar system. It is not unlikely that they are the smaller debris of the same catastrophe that produced the asteroids.

A second class is composed of those meteors that occupy orbits very similar to those of comets. In some cases these orbits are almost identical with those of known comets, or at least a comet once known, but which has since disintegrated. These are therefore *present* members of the solar system, but, for a number of reasons, it is not unlikely that the comets, and their meteors, are not original members of the sun's family. In fact they may be comparatively recent acquisitions.

The third class of meteors is rather heterogeneous but is composed chiefly of meteors that may not be members of the solar system at all. They furnish a large proportion of the fainter sporadic meteors. Many of these appear to have hyperbolic orbits, although some of the brighter sporadic meteors have been shown to have elliptical orbits. Some of these may be the smallest members of the first class. Others may belong to cometary systems that have long since been disintegrated. Meteors emanating from weakly active, but periodically recurring, radiants are especially likely to have once belonged to some vanished comet. The present paper is an investigation of the annual variation of this class of meteors.

Curves have been constructed showing the annual variation in the fall of recovered meteorites.[1] These show a rather sharp maximum in May-June with a poorly defined minimum in January.

Similar curves have been drawn for the number of observed meteors in general.[2] Most of these curves show a vague minimum in the first half of the year with a strong peak in August, and a smaller peak in October-November. One naturally attributes these minima to the Perseids, Orionids, and Leonids, respectively.

The author, being at that time unaware of the work of Hoffmeister[3] on this subject, wondered what the shape of the curve would be if the shower-meteors were removed, and whether the resulting curve would in any way resemble the curve for meteorites. To find an answer, use was made of newer data appearing in Meteor Notes from 1931 to 1949 inclusive.* No account was taken of the time of night during which the observations were made, except in so far as it influenced the date. Corrected rates were used provided that "F" was larger than 0.4, otherwise the data were discarded as insufficiently reliable. On shower-dates the shower meteors are sometimes distinguished from others, and in such cases they were subtracted from the total number and a new rate calculated. In other cases, suspiciously high rates occuring close to the date of an expected or possible shower were rejected because any attempt to correct for the shower meteors would be mere guesswork. On the other hand, a few abnormally low rates were

*Only a portion of the data in the A.M.S. files has been published. The published data alone were used.

also rejected when they were manifestly inconsistent with other rates for the same neighboring dates. Rates from the southern hemisphere were rejected because they were not uniformly distributed thruout the year, and were consistently higher than rates for the northern hemisphere. This last has also been noted by McIntosh.[6]

All of the usable data were collected by month and day of the month and the mean monthly and semi-monthly rates were calculated. Because the data were not uniformly distributed thruout the months, the means do not necessarily fall on the 15th day (monthly rates) or on the 7th and 22nd days (semi-monthly rates). Both curves are shown in Figure 1.

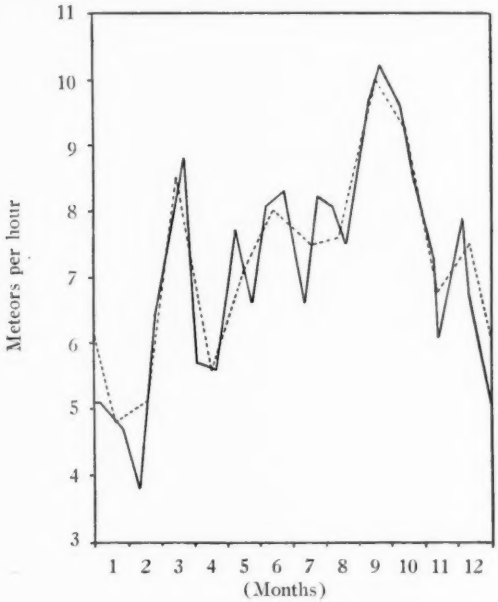

FIGURE 1
(Dashed line denotes monthly means; solid line, bimonthly means.)

A more detailed graph (which is not reproduced) indicates that the corrections for the Eta Aquarids, Delta Aquarids, Perseids, and Geminids may be slightly conservative, *i.e.*, not quite large enough. A larger correction however would be arbitrary and would not make a great deal of difference on the whole. The principal features of the graphs are the following:

1. There is a sharp minimum during the first half of February.

2. There are an unexpectedly large number of meteors visible in March. This "hump" is especially conspicuous since it comes so soon after the February minimum. In this month there are doubtless some minor radiants active and one so-called "shower" known as the Zeta Bootids visible March 10-12. Inspection of the data shows that this is not responsible for the minor maximum in March.

3. There is an unusual frequency of meteors in mid-June, another month in which there are no conspicuous or well-defined annual showers. Since this corresponds roughly to the meteorite maximum, it may be that this maximum is caused by bodies of the first class too small to survive the descent through the atmosphere.

4. There is a sharp maximum in mid-September but there is no conspicuous shower, or showers, to account for it. Inspection of the data indicates that this peak is more conspicuous in the last decade or so than formerly. H. H. Nininger has commented on the unusual frequency of bright meteors in and near September, 1941.[4] There seem to be two, or even three, possible showers contributing to this maximum. On September 14 and 16 the average rate is nearly 18 meteors per hour, but on the 15th it drops to 10. It is debatable whether we have one or two overlapping maxima here. The other maximum occurs September 21-22 with a rate of about 14 meteors per hour. In India, Dr. Khan has reported as many as 60 meteors per hour on this date! Can it be that there are two previously unsuspected showers in September? The hitherto inconspicuous Epsilon Perseids of September 7-15 might possibly account for the earlier maximum, but not for the latter one.

5. The apparently high rate in October may be spurious. It depends upon a relatively few, very high rates, that occur too early in the month to be attributable to the Orionids, and in years when the Draconids were not conspicuous. They also occur well past the Quadrantid shower. The author views them with suspicion, but does not feel justified in rejecting them.

6. The mean rate for the entire year is 7.3 meteors per hour.

In closing, the author wishes to urge A.M.S. members and their friends to make more observations in March and September in order to verify, or disprove, the apparent maxima in these months without conspicuous showers. Many persons make observations for a few nights preceding showers. This is very commendable, but, in the author's opnion, it would be an equally good idea to continue observations after the supposed maximum is past so that we may eventually trace the decline as well as the rise in shower rates.

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Flower Observatory of the University of Pennsylvania, Upper Darby, Pa.,
1949 June 3.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles 24

A Second Note on the Exclusively Meteoritic Minerals

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ABSTRACT

Troilite, which has been contended recently to be exclusively meteoritic, has one well-authenticated terrestrial occurrence. The identification of terrestrial clinoenstatite and clinohypersthene is subject to considerable doubt; it is therefore suggested that these minerals should be included in the list of exclusively meteoritic minerals. It is suggested further that taenite is properly excluded from this list. The revised list contains clinoenstatite (?), clinohypersthene (?), daubréelite, kosmochlor, merrillite (?), oldhamite, osbornite, phosphorus, schreibersite, and weinbergerite.

Troilite differs sufficiently from pyrrhotite in composition and physical properties to be considered a distinct mineral species, altho this conclusion was once a subject of much debate. Perry[1] considers troilite to be exclusively meteoritic. A search of the literature revealed that it is not, however. Eakle[2] describes an occurrence of massive bodies of troilite with magnetite in a sheared serpentine in Del Norte County, California. The identity of this material with troilite, in particular that from Canyon Diablo, Arizona, meteorites (Ogg), is adequately demonstrated. It is interesting to note that Eakle believes this terrestrial troilite to be a hydrothermal alteration of magnetite conditioned by the presence of excess iron; the presence of much iron may be the reason for the common occurrence of iron sulfide as troilite rather than as pyrrhotite, in meteorites. No other reported terrestrial occurrence of troilite was found.

Clinoenstatite[3] and clinohypersthene[4,5] have been reported as occurring in terrestrial basic igneous rocks. Henry,[6] however, as a result of a critical examination of data on Mg-Fe pyroxenes, was led to the conclusion that, with the exception of clinoferrosilite, there is no unquestionably terrestrial occurrence of monoclinic Mg-Fe pyroxene. All the reported terrestrial occurrences are based on extinction angles and a lamellar structure in impure fine-grained material; but these properties are insufficient to establish the identity of these minerals. Possibly the clinohypersthene described by Verhoogen[5] is an exception, but this material was not so adequately described as to establish its identification beyond doubt. The evidence for the terrestrial occurrence of clinoenstatite and clinohypersthene is not, then, without doubt; on the other hand, neither can the reported identifications be completely ignored. In view of the uncertainty, it is suggested that clinoenstatite and clinohypersthene be considered exclusively meteoritic, until definitely proved to be otherwise. If present on the Earth, these minerals are apparently very rare.

Taenite was included in my previous list of exclusively meteoritic minerals.[7]

The inclusion of this mineral in that list was based solely on the observation that terrestrial nickel-iron does not show exactly similar structures to meteoritic taenite, tho it is similar to the latter in every other essential respect. This conclusion is now seen to be without basis, since the structure assumed by an alloy is an expression of the course of its crystallization, which varies with different conditions. Accordingly, the identity of meteoritic taenite and terrestrial nickel-iron is considered established, and taenite is therefore excluded from the list of exclusively meteoritic minerals.

In conclusion, it is proposed that the list of exclusively meteoritic minerals be revised to contain the following mineral species: clinoenstatite (?), clinohypersthene (?), daubréelite, kosmochlor, merrillite (?), oldhamite, osbornite, phosphorus, schreibersite, and weinbergerite. The close similarity of merrillite to dehrnite was noted in my earlier paper;[7] in view of that similarity, it is thought best to include merrillite as questionable in the foregoing list.

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A Quantity for Evaluating the Effectiveness of Field Search in Meteoritics

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ABSTRACT

The *recovery index* of a meteoritic shower is defined and its application is discussed.

An exceedingly simple, tho very useful, quantity for measuring the effectiveness of field search for the specimens that fell during a meteoritic shower is the *recovery index* of the fall. This quantity shall be defined as the total number of individual masses and fragments recovered from an area showered by meteorites, divided by the total number of masses and fragments that fell in the area. The quantity may be expressed symbolically as follows:

$$R.I. = 100\,N\,(m_R)/N\,(m_F),$$

where $R.I.$ is the recovery index, $N\,(m_R)$ is the total number of individual masses and fragments recovered, and $N\,(m_F)$ is the total number of masses and fragments that fell. The factor 100 is included in the expression to make the recovery index a percentage. Since the exact determination of $N\,(m_F)$ is practically impossible, it is necessary to utilize techniques such as those developed

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by Dr. Lincoln La Paz[1] whenever these can be employed to obtain the *probable* value of $N\ (m_F)$. Since Dr. La Paz's method of determining the probable value of $N\ (m_F)$ presupposes the discovery of the meteorites, and since it is highly improbable that all the meteorites that fell during a shower are recovered, the range of values of the recovery index is evidently $0\% < R.I. < 100\%$.

Two falls for which the data necessary for the computation of the recovery index are available are the meteoritic (aerolitic) fall of Holbrook, Arizona, and the tektitic (australitic) fall of the Sherbrook River district in Australia.[1] The data and the recovery index for each of these falls are†:

Holbrook	*Sherbrook River*
$N\ (m_B) = 17{,}000$:	$N\ (m_B) = 135$
$N\ (m_F) = 100{,}000$:	$N\ (m_F) = 222$:
$R.I. = 17\%$	$R.I. = 61\%$

A low recovery index (*e.g.*, that of Holbrook) means that few of the specimens of the fall have been recovered, and accordingly indicates that the field search was relatively incomplete. A further implication of such an index is, of course, that more intensive field search would result probably in the discovery of additional specimens. A high recovery index (*e.g.*, that of Sherbrook River), on the other hand, means that the greater portion of the specimens that fell were recovered, and hence that the field search was comparatively successful; further field search would not be likely, then, to yield many additional specimens.

In a paper published in 1946, Dr. Frederick C. Leonard discussed certain desiderata for a general or comprehensive catalog of meteoritic falls.[2] One of the desiderata enumerated was "additional data for a multiple fall or a shower." Because of the simplicity and the conciseness of the recovery index and the usefulness of the information that it conveys, it is recommended for inclusion under this heading in such a catalog.

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A Note on Revised Wavelengths for a Composite Spectrum of a Perseid Meteor of 1948

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Subsequently to the publication of my paper on "A Composite Spectrum of a Perseid Meteor of 1948,"[1] Dr. Peter M. Millman of the Dominion Observatory at Ottawa, Ontario, Canada,[2] kindly called my attention to the fact that the wavelengths calculated for the 3 lines in the spectrum of the meteor, to the red of 5000 A., had probably been vitiated by the mis-identification of a local decrease in emulsion-sensitivity as the Hα line in the spectrum of δ Cassiopeiae, which was used in the reduction. Eastman "Super XX" emulsion exhibits a confusing drop in sensitivity near 5900 A., which, with very low dispersion, closely resembles a spectral line.[3] This was inadvertently assumed to be Hα, as Dr. Mill-

†A value followed by a colon (:) is approximate.

man had surmised, whereas, actually, Hα lies just outside the sensitivity-range of the emulsion.

With the aid of a laboratory dispersion curve for the prism used in obtaining the spectrum of the meteor, the ratio

$$\frac{H\alpha - H\gamma}{H\gamma - H\delta}$$

was determined and employed in calculating a comparator reading for the unrecorded Hα line in the spectrum of δ Cassiopeiae. Revised values were determined for the constants of a Hartmann formula based on Hα, Hγ, and Hϵ, and then for the wavelengths of the 3 lines in the spectrum of the meteor. The results of the wavelength revisions, together with new identifications, appear in Table 1, the first 2 and last columns of which are self-explanatory. The third column lists the elements, with their multiplet numbers in parentheses, which are probably involved in the formation of the spectral lines. The multiplet numbers are from Dr. Charlotte E. Moore's "A Multiplet Table of Astrophysical Interest, Revised Edition."[4] The fourth column contains computed wavelengths for the lines in the spectrum of the meteor, based on the wavelengths and intensities of the lines in the multiplets tabulated in the next preceding column.

TABLE 1

Old Observed Wavelength	New Observed Wavelength	Multiplets Involved	Computed Wavelength	O — C Wavelength
5245	5166	Fe I (1) Fe I (36) Mg I (2)	5173	—7
6492	5895	Na I (1)	5893	+2
7105	6185	Fe I (169) Fe I (207)	6176	+9

I wish to express my sincere thanks to Dr. Millman for bringing this error to my attention and for suggesting means for its correction.

References and Notes

[1] *C.M.S., P.A.*, **57**, 187-92, April, 1949.
[2] In a personal letter.
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More about the Wolf Creek, Western Australia, Crater (—1278,193)

We are again indebted to our member, Mr. J. Fraser Paterson, of Broken Hill, New South Wales, Australia, for news about the Wolf Creek, Western Australia, crater (*v.* the prior note in *C.M.S., P.A.*, **57**, 138-40, March, 1949). In a letter dated 1949 April 14, he writes: "I have pleasure in sending you a copy of *The Conveyor* for February, 1949, giving the latest information on the Wolf Creek crater." On p. 8 of that magazine (**7**, No. 2) appears an article by Frank Reeves, one of the discoverers of the crater, entitled "Western Australia's Wolf Creek Crater," and accompanied by "Two aerial shots of the crater taken by Pilot Dudley Hart on his first visit." Following is the final paragraph of Reeves' article:

"Messrs. R. S. Matheson and D. J. Guppy, in charge of the Commonwealth [geological] party, visited the crater on August 27 and 28, 1948, and collected small fragments of ironstone around its southern rim, which they thought were of meteor[it]ic origin. They submitted samples of this rock to the Western

Australia Chemical Laboratories for analysis, and gave me a fragment. At Dr. [H. G.] Raggatt's suggestion, I sent a piece of this ironstone to R. O. Chalmers, Curator of Minerals of the Australian Museum in Sydney, who is a noted specialist on Australian meteorites. Mr. Chalmers states that the ironstone is definitely of meteor[it]ic origin."

If Chalmers' conclusion as to the nature of the so-called "ironstone" is correct, then the presence of that material at the crater constitutes almost indisputable proof of the meteoritic character of the latter. It is to be hoped that more, unquestionably meteoritic material will in the near future be recovered at or in proximity to the crater.—F.C.L.

The Committee on a Textbook on Meteoritics

At the 11th Meeting of the Society in Albuquerque, New Mexico, in September, 1948, a resolution was passed instructing the President of the Society to appoint a Committee on the Compilation of a Textbook on Meteoritics. Under date of May 2, 1949, President King appointed the following 5 members, all resident in the Los Angeles area, to serve on such a committee: Dr. Frederick C. Leonard of the University of California, Los Angeles (Chairman); Mr. John Davis Buddhue of Pasadena; Dr. Joseph Kaplan, also of the University of California, Los Angeles; Dr. John A. Russell of the University of Southern California; and the President, *ex officio*. This committee will meet in time to make a report at the 12th Meeting of the Society, to be held in Los Angeles, California, in September, 1949.

Second Notice of the 12th Meeting of the Society

Attention is called to the notice that appeared in *C.M.S., P. A.*, **57**, 297, June, 1949, concerning the 12th Meeting of the Society, which will be held at the University of Southern California, Los Angeles 7, California, on 1949 September 6 and 7.

President of the Society: ARTHUR S. KING, 925 Topeka Street, Pasadena 6, California

Secretary of the Society: OSCAR E. MONNIG, 1010 Morningside Drive, Fort Worth 3, Texas

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

The A.A.V.S.O. Meeting at Brown University: Despite the all-day downpour on May 27, a very representative number of variable star observers gathered at the Ladd Observatory of Brown University, in Providence, Rhode Island, to attend the Spring Meeting of the A.A.V.S.O. Still more arrived on Saturday, the 28th, under more or less clouded sky conditions, and they, with many members of the Skyscrapers, formed a large unit at all of the scheduled functions.

The Council met at four o'clock on Friday afternoon, with ten of its members present, and five other members as invited guests.

The report of the Nominating Committee was accepted, with the following members proposed as candidates for the Council, to be voted upon at the October meeting; four of the six are to be elected.

Joseph Ashbrook	Donald H. Menzel
Cyrus F. Fernald	Peter M. Millman
Richard W. Hamilton	James S. Pickering

It was voted not to abandon the work of the Auroral Program, which was inaugurated some years ago, but instead to place it under the guidance of the Solar Division, with Mr. Roy A. Seely acting as Vice-Chairman and supervisor of that activity.

Thirty new candidates were elected to annual membership, the largest number elected at any meeting in many years.

Following an informal Dutch Treat dinner at the "Little Red Hen" restaurant not far distant from the Observatory, a large group from both associations gathered to hear a lecture by Mr. Harries-Clichy Peterson of the Finne Ronne Antarctic Expedition. Mr. Peterson, though young in years, proved a fine lecturer, and his kodachrome slides depicting the life south of Cape Horn were marvels of excellence. He spoke of the year spent in those waters, working in several fields of research, his own specialty being meteorology. Cloudy skies following the lecture prevented the use of the Ladd telescope, which was to have been used under the guidance of Dr. Charles Hetzler.

On Saturday morning the regular business session started shortly after ten o'clock. Dr. Bigelow, Vice-President of Brown University, welcomed us on behalf of the University, recounting a bit of the early history of the University in scientific fields, especially the part played by the Astronomy Department. The roll of thirty members elected by the Council followed, those present rising to be recognized as their names were called. The list follows:

Santiago Abascal, Calle Sola No. 255, Rpto. Suarez, Habana, Cuba
Audrey Arzinger, 38 Monona Avenue, Rutherford, New Jersey
Robert M. Adams, 324 South Valley, Neosho, Missouri
John W. Barris, 323 Main Street, Bridgeport, Ohio
Frank Bollmeyer, Jr., 3120 Wilkinson Avenue, Bronx 61, New York
Stanley W. Brower, 235 Second Street, Dunellen, New Jersey
C. Cardoso de Almeida, Alameda Lorena 245, Sao Paulo, Brazil
Donald F. Charles, E-4 329, Bayo Vista, Rodeo, California
Miles Davis, 1422 Rhode Island Avenue, N. W., Washington 5, D. C.
Giuseppe Di Domenico, 1581 Hollywood Avenue, Bronx 61, New York
Chrysostomos Drakakis, Damareos 70A, Pangrati, Athens, Greece
George E. Gagne, 560 Ch. Ste-Foy, Quebec, P. Q., Canada
George E. Gregory, 30 Virginia Avenue, Providence, Rhode Island
Freeman F. Hall, Jr., 2224 Yosemite Drive, Los Angeles 41, California
Neale E. Howard, Millbrook School, Millbrook, New York
James F. Jackson, 801 North Indiana Avenue, Bloomington, Indiana
Mark Kinsey, 8231 Tracey Street, Kansas City 5, Missouri
Charles E. Kratz, 3512 Dennlyn Road, Baltimore 15, Maryland
Arthur G. Laabs, 99 West Fulton Street, Gloversville, New York
Wayne M. Lowder, 3 Elm Place, Pelham 65, New York
William E. Meyer, 85 Berkeley Avenue, Westwood, New Jersey
Svend Mortenson, 650 Aircraft Control, 539 A.C.D. Group, Orlando Air Base, Orlando, Florida

Robert A. Naef, Scheideggstr. 126, Zurich 38, Switzerland
Alexander A. Panzer, 1245 East 83rd Street, Cleveland, Ohio
Carmine A. Stahl, Box 224, Hendrix College, Conway, Arkansas
Paul W. Stevens, 2322 Westfall Road, Rochester, New York
James W. Terry, R.R. 1, Kenwood, Champaign, Illinois
Andrew R. Wallbillich, R.D. 2, Altamont, New York
John E. Welch, 107 Lower Beverly Hills, West Springfield, Massachusetts
Ralph A. Wright, 4 Mason Street, Worcester, Massachusetts

A tentative date for the Annual Meeting in October was set as October 14-15, to be held, as usual, at the Harvard Observatory.

The list of papers read included those dealing with daytime visibility of stars, with and without a telescope, by members of the Skyscrapers Club, including one by Miss Wilhelmina Hull on "Bright Stars in the Daytime with the Unaided Eye," another by Elmer C. Hornby on "Stars in the Daytime with a Small Telescope," and third by Miss Elsie Ridings on "Stars in the Daytime with a 12-inch Telescope." All three papers evoked much interest and discussion. One of the most interesting of the morning papers was that presented by Dr. Louis C. Riggs of the Brown Psychology Department, on "Color Vision." This paper was of particular interest in connection with variable star observing.

Dr. Smiley explained his novel method of obtaining focal lengths of lenses by the use of photographic star trails. Mr. F. W. Hoffman showed his excellent color photographs of the April 12 lunar eclipse.

Variable star observing came in for no small share of interest when President Rosebrugh spoke on the "Variability of a Variable Star Observer." We can truthfully remark that there is plenty of variability in both the observer and the stars observed. "Notes on the AAVSO Variables" during this past year was presented by the Recorder, covering the antics of the SS Cygni stars; those of the R Coronae Borealis type, especially the recent deep drop to minimum of R Cor. Bor. itself; the 1948 nova in Serpens; and the Z Camelopardalis type stars. Plans are under way for the issuance of an AAVSO chart for the observation of Luyten's flare-up star, L 26-8, of which, according to reports, one component produces sudden outbursts in brightness of very short duration; all over within a matter of minutes.

The formal get-together meal was an elaborate luncheon at the Faunce House, with more than sixty persons present.

The afternoon session, presided over by Vice-President Heines, was devoted mainly to papers dealing with solar observing. Professor Walter L. Moore, of the University of Louisville, presented a paper on "Sunspot Activity at Louisville." This was Dr. Moore's first appearance at one of our meetings, although he has long been identified with us both as a variable star and sunspot observer. His method of projecting the solar image on a sphere instead of on a flat surface certainly sounds worthwhile. Mr. H. B. Rumrill's paper on "Some Aspects of Evolution in Sunspot Cycles" was read by Donald S. Kimball, and this was followed by a detailed paper on "200 Years of Sunspot Statistics" by Mr. Carlos Gartiz-Mata, in which he attempted to forecast solar activities in the years ahead. Miss Martha E. Stahr presented her third paper on "The Sun, A Microwave Variable." A paper by Mr. H. W. Clough on "Short Solar Periods" was read by Mr. Heines. Dr. James C. Bartlett's paper on the "Relation between Periodicity and Solar Granules" was read by Dr. Moore. Two papers by F. Harold Leinbach entitled "Equatorial Sunspots" and "Sunspot Activity from

October, 1947, to January, 1949," were read by title. A paper by John W. Streeter on the "Use of Photographic Filters in the Vassar College Refractor," was read by Mr. Richard Petzold. Mrs. Grace Rademacher showed some interesting slides of her 1948 trip through Spain, as well as others taken at the October, 1948, meeting at Harvard.

Following adjournment at 3:40 P.M., a cavalcade of autos set out for North Scituate for a visit to the Seagrave Observatory, which, by sundry and devious routes on the part of some drivers, was finally reached. While there, the solar observers had a chance to observe sunspots, and others to test their visual acuity in attempting to pick up bright stars and the new crescent moon low in the evening sky.

A picnic supper was later served in the North Scituate Baptist Church and, after some delay, the famous Palomar Observatory film was shown. Thus, after a lapse of eleven years since our first meeting at Brown, the second meeting, perhaps even more successful than that of 1938, came to an end.

The thanks of the Association are due to Dr. and Mrs. Smiley, to Dr. Hetzler, and to the Skyscrapers, for making our visit to Providence so pleasant and memorable.

Observations received during May and June, 1949: A total of 7,415 observations was received—3,833 in May and 3,582 in June—from the following 83 observers.

	May—1949—June					May—1949—June			
Observer	No. Obs.	No. Ests.	No. Obs.	No. Ests.	Observer	No. Obs.	No. Ests.	No. Obs.	No. Ests.
Adams	...	...	7	33	Focas	6	7	...	...
Ahnert	39	144	41	316	Ford	14	14	15	24
Ancarani	21	50	11	11	Garneau	6	6	11	11
Ashbrook	1	7	...	...	Gingerich	12	14	...	...
Babb	2	3	...	...	Greenley	56	110	47	102
Bajocchi	11	28	20	32	Halbach	21	21	26	26
Bappu, M. K.	31	40	26	58	Hardi	6	7	5	13
Bartha	5	13	6	7	Hartmann	139	156	136	139
Bicknell	11	40	15	97	Herring	14	18	13	23
Blunck	5	5	10	10	Howarth	16	18	...	...
Bogard	60	144	63	102	Huffer	4	5	...	...
Bonelli	1	1	...	...	Jager	...	...	4	4
Buckstaff	13	18	20	26	Kantor	8	19	6	18
Bufkin	1	1	4	6	Kelly, F. J.	9	10	10	10
Cain	13	17	5	7	Kelly, L.	...	...	11	11
Chandra	...	...	14	19	Kirchhoff	44	105	39	140
Charles	6	13	9	16	de Kock	119	576	121	449
Chassapis	44	44	...	...	Lacchini	72	190	60	72
Cilley	31	50	...	...	Langford	10	34	4	25
Cragg	...	...	13	13	Lee	10	14	21	33
Daley	7	10	8	13	Lovas	...	...	6	10
Darling	...	...	13	22	Lowder	12	20	20	21
Darnell	4	7	2	5	LaVaux	...	...	4	4
Davis, M.	10	16	4	5	Luft	5	9	2	8
Dillon	5	9	8	11	Lyons	1	2	...	...
Drakakis	10	213	...	...	Miller	23	29	31	42
Edelenyi	2	4	5	7	Oravec	63	177	50	107
Escalante	12	12	71	71	Parker	38	38	32	32
Estremadoyro, G. A.	1	3	1	2	Parks	17	17	22	22
					Stevens	...	...	6	15
Estremadoyro, V. A.	8	27	9	9	Pearcy	77	80	84	84
					Peltier	185	260	169	255
Farnsworth	7	7	...	...	Penhallow	17	24	23	36
Fernald	250	545	256	457	Pearson	27	27	22	22

Observer	May—1949—June No. Obs.	No. Ests.	No. Obs.	No. Ests.	Observer	May—1949—June No. Obs.	No. Ests.	No. Obs.	No. Ests.
Rakosi	5	6	...	...	Toth	7	29	8	43
Renner	102	102	110	110	Upjohn	9	9	40	49
Rosebrugh	17	84	11	51	Venter	...	...	21	53
Shen	17	46	...	...	Webb	...	...	28	38
Skinner	4	5	...	...	Weber	...	...	40	40
Slemaker	8	8	...	...	Wells	1	1	...	...
Snow	...	...	2	2	Yamada	...	...	16	40
Taboada	26	26	25	25	—				
Tarbell	9	16	6	8	83 totals		3,833		3,582
Tifft	15	23	10	10					

July 15, 1949.

Comet Notes

By G. VAN BIESBROECK

Since the previous notes were written two new comets have been announced.

Comet 1949 *a* (Johnson) was found by E. L. Johnson on plates taken at the Johannesburg Observatory (South Africa) on May 20. This same observer was responsible for the discovery of Comet 1948 *j* last fall. The new object was situated too far south for northern observers at the time of discovery but it was moving slowly north-west so that on June 18 it could be recorded here at low

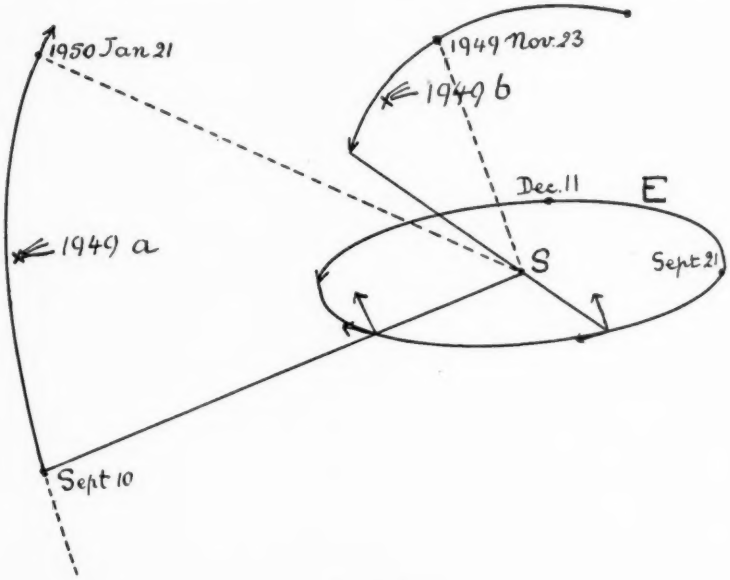

Figure 1
The Orbits of Comets 1949 *a* and *b*

altitude as a 13th magnitude fuzzy spot with a well-defined central nucleus. The following orbits have been computed:

Computer	Cunningham	Bobone
Interval covered	4 days	8 days
Time of perihelion	1950 Jan. 21.8365	1950 Jan. 20.7097
Node to perihelion	42°.967	41°.379
Longitude of node	221.990	221.775
Inclination	130.808	131.120
Perihelion distance	2.4667 A.U.	2.5157 A.U.

The orbit is represented in Figure 1 where the earth's path (E) around the sun (S) is illustrated by a closed ellipse. The comet remains far from the sun moving from south to north, crossing the plane of the earth's orbit on September 10. However, it will not be visible at that time because of the nearness of the sun. Not until later in the year will it become observable as a morning object. Next spring it will be favorably placed but may not become brighter than the tenth magnitude.

Comet 1949 *b* (Bappu, Bok, Newkirk) was found on a photographic plate taken at the Oak Ridge Station of the Harvard Observatory on July 2. The comet was described as being of 13th magnitude with a central condensation. The location then was:

1949 July 2.30537 R.A. $19^h\ 47^m.0$, Dec. $+38°\ 36'$,

which is in the constellation of Cygnus. The motion originally given as north-eastward was afterwards corrected to north-west. Being very favorably located the comet was recorded at several observatories and a preliminary orbit computed by Hamid Bappu became available within a week as follows:

Perihelion time	1949 Nov. 22.915
Node to perihelion	123° 33′ }
Longitude of node	310° 48′ } 1949.0
Inclination	108° 24′ }
Perihelion distance	1.3654 A.U.

From these I have computed the following ephemeris:

1949	α h m	δ ° ′	Mag.
July 31	17 33.8	46 50	12.6
Aug. 8	16 56.0	46 19	12.5
16	16 23.6	44 53	12.4
24	16 0.5	43 08	12.3

The arc from discovery to perihelion is represented in Figure 1 which shows the spatial relation of the two comets, 1949 *a*, and *b*, and the earth. This comet will remain observable for several months but it is not expected to become bright.

The only other comet visible at this time is 1948 *h* (Wirtanen) but it is near the south pole. J. M. Bester found this object independently at the Harvard Station in Bloemfontein on May 29 and announced it as a new object 1949 *b*. But this designation has to be dropped since the comet had been under observation for many months in the southern hemisphere.

It is not impossible that further observations of comets 1948 *d* and *k* may be obtained in the latter part of the night but both objects are extremely faint at this time.

Williams Bay, July 12, 1949.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

How Did the Solar System Originate?

He who would account for the Solar System must be a competent detective. Witnesses are not available and clews are few and vague. But he cannot hope for success unless he respects such clews as he has.

The clews are as follows:

(1) The regularities of the Solar System, namely,

(a) The spacing of the planets approximately according to Bode's Law.

(b) The increase in size of the planets up to Jupiter, and the uniformly relative small size of the inner planets.

(2) The miniature systems of Uranus, Saturn, and Jupiter.

(3) The law of "angular momentum."

(4) The dynamic plane of the planetary orbits inclines 7 degrees to the Sun's equator.

(5) The accelerated speed of the inner satellite of Mars.

(6) The fact that Venus shows no equatorial bulge.

(7) The retrograde revolution of Neptune's satellite.

(8) The great inclination of the orbit of Pluto and of those of many Asteroids.

(9) The eastward revolution of all the planets.

(10) "Bodies with the masses of the planets could not be formed from gaseous matter. The gas would disperse instead of condensing."

(11) The axis of Uranus being nearly parallel to the plane of its orbit.

The following theory would seem to be consistent with the above-mentioned clews. It is hereby turned over to the tender mercies of the mathematicians and the physicists.

The Uranus Theory of the Solar System

This theory was developed as follows:

How did Uranus get tipped over so far that its equator makes an angle of 98 degrees to the plane of its orbit, thus giving it a retrograde rotation? But did it get tipped over? It would be easier to assume that such was the position of all the planetary axes originally and that the other planets were straightened up by the attraction of the Sun on their bulging equators. Mercury and Venus, without bulging equators, are as yet an unknown factor in the problem. But the question may be raised as to whether the fact that Venus has no perceptible bulge and the fact that its period of rotation has not yet been definitely fixed will not eventually prove that its axis is nearly parallel to the plane of its orbit, as in the case of Uranus. It is certainly strange that a planet so nearly like the Earth in size, mass, and location should show no flattening at the poles and no indication of a rotation comparable to that of our planet.

But why should the original position of the planetary axes have been approximately horizontal? We can know but little of the internal condition of the supergiant stars. But we may assume that it is far more turbulent than that of our relatively stabilized Sun. The pulsating of a variable star is evidence of a titantic

struggle between the force of gravity, which would reduce it to the size and density of a white dwarf, and the forces of radiation and expansion, which, at times explode a star into a super-Nova. At present the Sun, in its middle-age maturity, is fairly well stabilized. We may regard the sunspots and the prominences as vents for the escape of surplus expansive forces, which, if rigidly confined, would eventually blow up the Sun into a Nova. But, in the days of its youth, while it was "sowing its wild oats," what terrific disturbances must have heaved within its bosom?

Epsilon Aurigae is estimated to have a diameter of from 2000 to 3000 times that of the Sun. It would almost fill the orbit of Uranus. Its temperature is estimated at 1700 C. at its surface and close to 1,000,000 C. at its relatively dense center. Assume the Sun to have once been still larger, and the pressure on its center to have increased while the temperature also increased until the expansive forces overcame the compressive forces. What might have happened then? Perhaps this started pulsation. Or, perhaps, at times during the Sun's contraction, it caused an eruption of a fission that sent a mass of condensed gas whirling toward the surface, expanding and cooling as it went but still maintaining its identity. Perhaps this served as a vent against pulsation. In this way, by a double fission, Pluto and Neptune could have been formed at the same time. Increasing pressure, density, temperature, and explosive power would naturally have produced the more massive Saturn, and would have culminated in the prodigious cataclysm that formed Jupiter. The insignificant combined mass of the Asteroids and the relatively small mass of Mars suggest an exhaustion of the Sun's explosive power after the expulsion of Jupiter. The small masses of the other planets would indicate its increasing stabilization. The spacing of the planets would naturally follow the laws of balance between the compressive and the expansive forces in a shrinking star. These seem to have caused the approximations to Bode's Law.

The recurrence in some stars of nova-like outbursts varying both in intensity and in periodicity greatly strengthens the foregoing assumptions. The gases expelled from the Sun in such explosions would naturally disperse.

As the whirling mass moved toward the surface, it cooled, until, when left behind by the contraction of the Sun, it could still hold together. Either before or after the whirling mass left the Sun, it would naturally throw off satellites.

As the Sun receded it left behind this rotating planet with its axis pointing approximately toward its center. An equatorial bulge soon developed. The attraction of the Sun on this bulge tended to bring it into the plane of the planet's orbit, but the gyroscopic rotation kept the axis from becoming vertical. The planet Jupiter, being by far the heaviest, responded the furthest until its equator inclined only 3 degrees and 7 minutes to the plane of its orbit, whereas those of the others, except Uranus, varied between 23 degrees and 27 minutes and 29 degrees.

But the position of Uranus was such that the attraction of the Sun was so nearly equal along the planet's equator that it could only cause it to wobble a little. Perhaps that is the reason why its rotation and the revolutions of its satellites are retrograde.

To assume the planets to be condensed sunspots will explain why the dynamic plane of their orbits is inclined 7 degrees to that of the Sun's equator, for sunspots rarely form at the equator. Abetti states: "At the minimum period there are two sunspot zones; one at 20 degrees belonging to the new cycle and one at 7 degrees belonging to the cycle that is about to end." Is there any significance in this?

The great inclination of the orbits of so many Asteroids might be due to a scattering of a weakened explosive force, which was unable to expel them as a single planet.

The Uranus theory should be adjustable to the law of angular momentum.

It fully accounts for the eastward revolution of all the planets, for the ejected matter would move in the same direction as the Sun's rotation, as in fission.

It should answer the objection, urged against other theories, that such small masses of gases could not condense into planets, as the condensation would take place within the Sun itself.

The retrograde satellite of Neptune was probably separated by fission while Neptune was being swayed by terrific forces within the Sun. Or it might have been formed at the same time as the planet itself.

It is possible that all true satellites were separated before the planet was finally disengaged from the Sun.

The tiny satellites of Jupiter and Saturn are doubtleses captured Asteroids.

The accelerated speed of the inner satellite of Mars can be charged to some force within the Sun before Mars was finally disengaged.

The relatively great mass of our Moon suggests fission, probably before the Earth was disengaged from the Sun.

From the foregoing we may conclude that the planets were formed within a giant Sun by successive explosions or fissions caused by an imbalance between the forces of compression and those of expansion.

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Box 2025, Portland 14, Oregon.

Lights on the Moon

I have noted with interest Mr. Stanley Ogilvy's article on "Lights on the Moon," in your May issue, because of the bright spot that appeared in the umbra on the occasion of the recent total eclipse. I have looked for reports on this occurrence in the recent publications, but have found none. Surely it must have been observed by others.

We were observing with a 4¼-inch refractor and watching the three stars below the moon to see whether any of them would be occulted before the sunlight blotted them out. At the end of totality, when the crescent of light had covered about 1/16 the diameter of the moon, a bright spot of light appeared in the shadow, near the middle of the illuminated zone and about ⅛ diameter from the limb. It was star-like and white, in marked contrast with the red-orange color of the shadow. It was confirmed by three independent observers.

We watched it as the light approached it, and it remained unchanged until the light covered it. Then it was still visible, but appearing as a lighter spot of substantial area.

When the moon became illuminated we identified it as the high crater, Aristarchus, and it was apparent that something on the mountain must have caught a reflection from something in the illuminated zone.

Three features were conspicuous:

1. The star-like appearance of the gleam,
2. The white light, in contrast with the red-orange of the background umbra,
3. Its appearance only after sunlight had touched the moon.

Study of photographs shows high and very bright mountains in the illumin-

ated zone, the highest and brightest being near the end of the illuminated crescent and about 250 miles from Aristarchus. There are other and nearer mountains, apparently lower, farther North. These would seem to be the source of light for the bright spot.

A little calculation indicates that for two mountains 200 miles apart to have line-of-sight visibility over the hump of a sphere the size of the moon, they should have an altitude of about 26,000 feet above the sphere. For a distance of 130 miles the altitudes should be over 10,000 feet. Since differences of altitude over 26,000 feet are known on the moon, and since the space between Aristarchus and the bright mountains looks like a plain and might be a depression, the reflection hypothesis seems not unreasonable.

If you have had other reports from observers of this phenomenon, I would greatly appreciate the courtesy of telling me of them.

FREDERICK K. VREELAND.

36 Magee Avenue, Mill Valley, California.
June 24, 1949.

Some Biblical Anticipations in Astronomy

It has been well said that the limitations of the Bible lie rather in ourselves than in the Old Book itself, whereof the full meaning often awaits our progress in knowledge. To begin with, we now realize how fundamental light is, in its sundry forms of radiation; hence why the Creator began His work with the fiat, "Let Light be" (Genesis 1:3). With light is associated the "ether" medium for its transverse oscillations; which medium is anticipated in the actual meaning, three dimensional, of "solid curtain" or "gauze," *cf.* Isaiah 40:22. This verse also anticipates the sphericity of our Earth, with its stated "circle."

Our discovery of diurnal rotation, we find anticipated in Job's words (38:14) about the earth being "turned as clay to the seal," not to mention the like implication in daytime and nighttime occupations to be simultaneous with the Second Advent of New Testament prophecy. The same prophet (Job 26:7)—perhaps the earliest in the Bible—also tells us that God "hangeth the earth upon nothing"—poised in space, as we have now found out. So much for the Earth.

The Sun, spoken of (Psalm 19:5, 6) in geocentric terms as making his daily circuit of the sky, is also said to rejoice as a strong man to run his course, as distinct from the said circuit; may we not here recognize his now known path toward the apex in Hercules?

About the Stars, again Isaiah tells us (40:26) that God "calleth them all by names," the Biblical word for "characteristics," whereof the diversities are the preoccupation of modern astro-physics. The root meaning of the Hebrew word for "star," in fact, is that of a "rolling ball": a dual anticipation: that the stars are spheres, also, as lately discovered, that they rotate; or the reference might be to binaries? Our tendency to treat the stars merely as gigantic laboratories, may well rob us of the romance of their individuality in creation, "when the morning stars sang together" in chorus with "all the sons of God shouting for joy" (Job 38:7). Perhaps, in this connection, we may find there is something of actual "noise" in the cosmic radiation which we so call in our present state of knowledge.

Regarding Cosmos, we can now appreciate the force of Proverbs 8:27, telling us of the "compass (circle) set upon the face of the depth" at creation, namely the curvature of space, as distinct from the "circle of the earth," above mentioned.

Of the earth's foretold fiery end (2 Peter 3:12-15) we may see anticipation in the supernovae, heralding the end or rebirth of other systems in space, the fissure of the atom on celestial scale, and which on earth men have begun to fear already—as foretold (Luke 21:26); "men's hearts failing them for fear, and for looking after those things which are coming on the earth: for the powers of heaven shall be shaken."

Cultivating, shall we say, the four dimensional look in scientific research, we may find the path to real knowledge strewn with fewer discarded theories. So "retaining God in knowledge," and eschewing the credulity of the unbelief that rejects "without excuse" the witness of creation, the scientific mind will not "become vain in its imagination," nor its "heart darkened" (Rom. 1:19-22, 28).

O. R. WALKEY, F.R.A.S.

General Notes

Mr. Leon Campbell, well known to every one the world over who has had anything to do with variable stars, for many years the recorder and the guiding influence in the activities of the American Association of Variable Star Observers, received a well-merited honorary degree of Master of Arts at the Harvard Commencement on June 23.

Dr. Frederick C. Leonard, Professor of Astronomy in the University of California, Los Angeles, and Editor of The Meteoritical Society, lectured before the Los Angeles Astronomical Society, meeting at the Griffith Observatory and Planetarium, in the evening of July 11, 1949, on "Meteorites: Captives from Space." The lecture was illustrated with both lantern slides and specimens.

Mr. James Stokley, science writer and lecturer in the General Electric Research Laboratory, Schenectady, N. Y., was honored by Wagner College in the conferring of the degree of Doctor of Science at its commencement on June 3. This is the first time that this degree has been conferred by Wagner College. Dr. Stokley has been associated with the General Electric Company's Advertising and Publicity Department since 1941.

Lunar Nomenclature

Our attention has been called to the fact that the list of names of American scientists associated with features on the moon, given on page 301 of the preceding issue, is far from complete. A complete list would include, in addition to those given, the following: Agassiz, G. P. Bond, W. C. Bond, E. W. Brown, Draper, Franklin, Gould, Holden, Kane, Maury, Peirce, E. C. Pickering, and W. H. Pickering.

Cleveland Astronomical Society Meeting

The speaker at the dinner meeting of May 27 was the photoelectric expert, Dr. Gerald Kron of the Lick Observatory, who spoke on the topic, "The Lick Observatory and its Work." Among the difficulties peculiar to astronomy in general which were mentioned in his preliminary remarks are the following: the unavailability of the data, the delicacy of the measurements, and the length of

the time-scale. Large telescopes and improved techniques are necessary to combat these factors.

Several interesting points relative to the early history of the observatory were brought out. For example, the bid of the Warner and Swasey Company was accepted even though it was the highest offered, because of the high regard for that firm. The only pre-Lick picture of the mountain available to the speaker contained a record of an activity not directly connected with astronomy—a brewer's picnic. The hydraulic motors used (in the days before electricity) to wind the clock, raise the floor, and move the dome were described. The primitive roads and the famous feuds which arose because of "mountain-sickness" provided interesting high-lights. The earthquakes of 1906 and 1912, the director who "repaired" his home by tearing down all but one wall and then rebuilding, and the recent airplane crashes (one at the observatory, one farther down the mountain) were all engagingly presented.

The Crossley reflector was mentioned as being the most useful general purpose instrument at the observatory, despite the fact that it is awkward to use at first. The other equipment was discussed, as well as the plans for the 120-inch reflector, excavation for which is in progress. A preliminary answer to a question concerning the work of the observatory involved the negative approach: no solar work is done there. The actual "division of labor" among the staff members was then described.

The large crowd (about 125) thoroughly enjoyed the pleasant, humorous, and competent lecture on the activities of this famous California observatory.

The following officers were elected for the coming year:

President	Dr. J. J. Nassau
Vice-President	Dr. S. W. McCuskey
Vice-President	Mr. E. N. Jennison
Secretary-Treasurer	Mrs. S. K. Towson
Recording Secretary	Dr. Paul Annear

PAUL ANNEAR, *Recording Secretary.*

Burrell Observatory, Baldwin-Wallace College, Berea, Ohio, 28 May 1949.

A New Definitive Sky Atlas

The first of some 2,000 pictures of the heavens which will provide the world with its first definitive Sky Atlas was taken by the 48-inch Schmidt Telescope on Palomar Mountain on the night of July 19. The date for the "first pictures" was determined by the National Geographic Society, which is sponsoring the project, and the Mt. Wilson-Palomar Observatories, which will carry out the program.

A ceremony was held in the Schmidt dome that night, after which Dr. Albert G. Wilson and two assistants on the Mt. Wilson-Palomar staff will begin a job that will require four years to complete. Scientists representing the National Geographic Society and the Observatory were on hand to see the project officially launched.

When the work is completed in 1953, a map of three-fourths of the sky out to an average of 300,000,000 light years will have been obtained, and will be known as the National Geographic Society-Palomar Observatory Sky Atlas. Copies of the atlas will be made available to other observatories and institutions throughout the world at cost. (*A news release from the California Institute of Technology.*)

An Unusually Near Asteroid

A minor planet, technically an asteroid, that approaches closer to the sun than any other known to astronomy and which astronomers will be able to continue to observe, has scientists at the Mt. Wilson and Palomar Observatories and others throughout the country training their telescopes near the bright star Antares.

The new "unusual" baby planet was discovered by Dr. Walter Baade of the Mt. Wilson-Palomar staff on a 48-inch Schmidt Telescope plate which he made on the night of June 26 on Palomar Mountain. Upon examining the plate the following day Dr. Baade observed a narrow streak among the round star images indicating the presence of a fast-moving body. It looked as if the object might be an asteroid extremely close to the earth. On the evenings of June 28 and 30 he took two more photographs so that he would have enough to determine the object's path, or orbit, in the sky.

The three plates were turned over to Dr. Seth B. Nicholson and Dr. Robert S. Richardson of the Mt. Wilson-Palomar staff for measurement and computation of the orbit. This work has just been completed. They found that the new minor planet was indeed an extraordinary one, in fact the most unusual of some 1535 asteroids whose orbits have been determined.

For one thing, it passes closer to the sun than any known body except a comet and is the only known minor planet to pass inside the orbit of Mercury. Furthermore, computation of its orbit shows that it can approach within 4 million miles of the orbit of the earth. On June 21 it was within 8 million miles of the earth.

From its apparent brightness, the astronomers inferred its diameter to be about 0.9 mile. It takes 343 days to revolve about the sun and is now receding from the earth.

Its orbit is elongated and has roughly the shape of a football. When it passes within the orbit of Mercury it is within 22 million miles of the sun, while at the other extreme it recedes out beyond the orbit of Mars to a distance of 156 million miles.

While other minor planets have approached much closer to the earth—one named Hermes came within 485,000 miles or about twice the distance of the moon at one time—the new asteroid appears to be one of which astronomers can keep track. Hermes disappeared and hasn't been seen since, and this has been true of others which have approached close to the earth, been observed, and then lost completely.

Photographs were again taken by the 48-inch Schmidt on July 12 and 13 and again picked up the new tiny planet. If astronomers can keep track of this new asteroid—and it appears that they can—it may well prove of great value in two ways. It, along with a few others observed to exist much closer to the sun than previously supposed, may prove of value in man's attempt to solve the mystery of the evolution of the solar system. Objects such as this may also be found valuable in supplying more data for determining the mass of Mercury, which is still quite uncertain.

If, as now seems relatively certain, the new asteroid approaches closer to the earth than any other of which astronomers have been able to compute an orbit, Dr. Baade has the distinction of finding baby planets at two extremes. Back in 1924 he discovered the asteroid named Hidalgo which goes farthest from the sun of any known minor planet, out to 900 million miles to the orbit of

Saturn. Now, 25 years later, he has discovered the body that comes nearest to the sun—within 22 million miles.

Astronomers computed the maximum temperature a body would have at a distance of 22 million miles from the sun—closest approach of the new asteroid—to be about 1000 degrees Fahrenheit, although the surface temperature is probably much lower than this. Six months later, when the new planet is at the other end of its path its surface must be well below the freezing point of water, Drs. Robertson and Nicholson said. (*A news release from the California Institute of Technology.*)

Provisional Relative Sunspot Numbers for May, 1949*

Day	R	Day	R	Day	R
1	77	11	106	21	100
2	74	12	62	22	111
3	121	13	60	23	119
4	122	14	56	24	140
5	139	15	69	25	120
6	140	16	80	26	103
7	132	17	111	27	114
8	118	18	111	28	98
9	114	19	110	29	119
10	100	20	105	30	120
				31	97

Monthly Mean 104.7

Provisional Relative Sunspot Numbers for June, 1949*

1	116	11	102	21	92
2	114	12	86	22	115
3	116	13	119	23	139
4	119	14	122	24	137
5	107	15	85	25	116
6	134	16	103	26	164
7	108	17	86	27	203
8	109	18	85	28	233
9	83	19	90	29	237
10	85	20	83	30	218

Monthly Mean 123.5

Provisional Relative Sunspot Numbers for July, 1949*

1	156	11	59	21	142
2	124	12	95	22	150
3	138	13	107	23	171
4	100	14	91	24	182
5	67	15	113	25	187
6	79	16	113	26	164
7	86	17	105	27	182
8	61	18	109	28	164
9	57	19	136	29	185
10	52	20	144	30	185
				31	196

Monthly Mean 125.8

Predictions of the smoothed monthly sunspot numbers for the coming 5 months:

August	120	November	108
September	116	December	104
October	112		

*From the Zürich Observatory, furnished by Mr. Neal J. Heines.

Book Review

Atlas of the Heavens, by Becvar, Skalnate Pleso Observatory, Czechoslovakia, 1948; American Edition, from duplicate negatives, with Foreword by Zdenek Kopal. (Sky Publishing Corp., Cambridge, Mass., 1948; $5.00 unbound.)

This atlas, the most comprehensive and detailed general reference atlas of the sky yet to appear, covers the entire sky from pole to pole in 16 large-scale charts, 15 by 21 inches exclusive of borders. In completeness, accuracy, realistic appearance, and draftsmanship it leaves nothing to be desired.

Each chart covers a region of the sky approximately 45° to 50° wide in declination, with a uniform declination scale of 0.3 inch = 1°. Projections giving straight hour circles are used, and distortions are not noticeable. All stars brighter than magnitude 7.75 are plotted accurately, in symbols graded in brightness by half-magnitude intervals. Where the positions of two or more close stars cause overlapping of the symbols, the stars are separately indicated by white rings in the larger symbols.

It is in representation of special objects that the high character of the Atlas is most impressive. Variable stars are indicated by their designations and by special symbols. Visual and spectroscopic binaries and multiple stars are designated by special symbols indicating the number of components. Novae are shown. Galactic clusters, from diameters less than 1′, and all known globular clusters and planetary nebulae are indicated. Bright and dark diffuse nebulae are shown, and the actual outlines of those larger than 10′ in diameter are painstakingly drawn. Even the "Horse Head" in Orion is recognizable in form. Over 1,000 extragalactic nebulae are plotted, in symbols graded by size. NGC or IC and M numbers are given for clusters and nebulae. The galactic equator is shown, and the Milky Way and prominent obscuring clouds within it are indicated by isophotic lines. Constellation boundaries are drawn clearly but unobtrusively.

Each chart sheet includes a general key of all symbols. These are labeled in Latin, but the similarity in practically all cases of the Latin and English astronomical terms is such that no important difficulty will be experienced by those unfamiliar with that language.

The drawing is beautifully and precisely done, the printing is excellent, and the paper is heavy and of excellent quality. Dr. Becvar and his assistants at the Skalnate Pleso Observatory are to be heartily congratulated on a truly great work involving immense labor and carried out with rare skill and almost unbelievable perfection. There will be, also, general appreciation of the Sky Publishing Corporation's making this atlas so promptly available to American users at such a moderate cost. The Atlas will be of immense value to both professional and amateur astronomers everywhere, and belongs in every astronomical library.

PHILIP S. RIGGS.

Drake University, Des Moines, Iowa.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who sent them.

Contributions from the Dominion Astrophysical Observatory:

No. 9. "The Orbits and Dimensions of the Components of the Spectroscopic Binary H.D. 43246," by R. M. Petrie.

No. 10. "Wave-length Standards for Radial-Velocity Determinations, II, The A-Stars with High Dispersion," by R. M. Petrie.

No. 11. "Wave-Length Standards for Radial-Velocity Determinations, III. The A-Stars with Single-Prism Dispersion," by R. M. Petrie.

No. 12. "Wave-Length Standards for Radial-Velocity Determinations, IV," by Jean K. McDonald.

No. 13. "A New Projection Instrument for the Rapid Determination of Stellar Radial Velocities," by R. M. Petrie and S. S. Girling.

No. 14. "Axial Rotation of the Brighter Stars in the Pleiades Cluster," by Elsa van Dien.

No. 15. "The Far Violet Region in the Spectra of the Cool Carbon Stars," by Andrew McKellar.

No. 16. "Polyatomic Molecules in Late-Type Stars," by P. Swings and A. McKellar.

Harvard College Observatory *Circular* 453.

Harvard College Observatory *Bulletin* 919.

Harvard Reprint:

No. 316. "Variable Star Notes from the American Association of Variable Star Observers in 1948," by Leon Campbell.

No. 317. "Association of Corona with Prominence," by Walter Orr Roberts.

No. 318. "A Study of the Orbit of Beta Aurigae," by S. L. Piotrowski.

Harvard Reprint Series II:

No. 22. "Study of a Close Approach of Comet Whipple 1933*f* to Jupiter in 1922," by Richard N. Thomas.

One Hundred and Third Annual Report of the Director of The Astronomical Observatory of Harvard College for the Year ending September 30, 1948, by Harlow Shapley.

EDITOR'S NOTE

In a note in the June issue, the reason for the lateness of the August issue was given. A visit to the large observatories on the Pacific coast required somewhat more time than was anticipated and consequently this issue is a little later than was planned. It is hoped that no one has been seriously inconvenienced thereby. The October issue will appear about October 1 as usual.

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